CHAPTER 14

NEICO STATE LEASES ML-21568 AND ML-21569

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14.0 NEICO STATE LEASES ML-21568 AND ML-21569

14.1 Introduction

This chapter contains information for an underground mining permit for state leases ML-21568 and ML-21569 located in T16S-R6E-Sec2 and T15S-R6E-Sec36 SLBM respectively, by Genwal Coal Company Inc. (Genwal), jointly owned by Nevada Electric Investment Company (NEICO) and Intermountain Power Agency (IPA) (Plate 2-1). A special use permit for a right-of-way (Chapter 13) to access these contiguous state coal leases, from federal coal leases UO-54762 and SL-062648 has been obtained from the Utah Division of Oil, Gas and Mining.

State leases ML-21568 and ML-21569 are 998 and 640 acres in size, respectively. In-place coal reserves total 18 million tons, of which 8 million tons will be recovered.

Mining of these two leases will not result in additional surface structures. All work performed will be done underground. Access will be solely via one set of presently existent portals in the Hiawatha coal seam located in lease SL-062648.

An underground mine design for these two state leases appears in Plates 3-3 and 3-3A. Detailed discussions of the underground mine design and mining plans are found in sections 14.6.1 and 14.3.2, respectively. Typical entry-ways are 20 feet wide. Lease ML-21568 contains 12 retreat panels, barrier pillars, a north-south main (1st South), and a bleeder (2nd South). Barrier protection, nine retreat panels, a main entry (Main North), as well as a north-south bleeder (1st Right) have been designed in Lease ML-21569.

Information concluded from present drill hole information excludes the possibility of multiple minable seams being present on either State Lease. However, Genwal Coal Company will drill up holes from the Hiawatha Seam in lease ML-21568 (Appendix 6-5). The up holes will be drilled up a maximum of 150' in an attempt to locate and evaluate the Blind Canyon and Bear seams to their potential to be feasibly mined. The up holes will be drilled on one-half mile spacing in

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An underground mine design for these two state leases appears in Plate 3-3. Detailed discussions of the underground mine design and mining plans are found in sections 14.6.1 and 14.3.2, respectively. Typical entry-ways are 20 feet wide. Lease ML-21568 contains 12 panels, barrier pillars, a north-south main, and an east-west submain. Barrier protection, retreat rooms, eight panels, a main entry, as well as north-south and east-west submains have been designed in Lease ML-21569.

Information concluded from present drill hole information excludes the possibality of multiple minable seams being present on either State Lease. However, Genwal Coal Company will drill up holes from the Hiawatha Seam in lease ML-21568 (Appencix 6-5). The up holes will be drilled up a maximum of 150' in an attempt to locate and evaluate the Blind Canyon and Bear seams to their potential to be feasably mined. The up holes will be drilled on one-half mile spacing in the mains as they are being developed. Should in the unlikely event that a minable seam be found above the Hiawatha seam, it will be evaluated for potential mining prior to any second mining of the Hiawatha seam in lease ML-21568. Drill hole information in lease ML- 21569 is completed and there is no indication of any minable seams other than the Hiawatha. Therefore, no additional up holes are planned for lease ML-21569.

A determination has been made that mining of State Leases ML-21568 and ML-21569 in Crandall and Blind Canyons should not have an adverse impact on environmental quality. Work in these leases will not effect any surface features. Surface and groundwater should not be adversely effected in the permit areas or adjacent areas. Fish and wildlife, human values (historical and cultural), and vegetative resources should not be adversely impacted.

This document is organized similar to:

1) the Genwal Coal Company Mining and Reclamation Plan, Crandall Canyon Mine, which was organized as suggested by the revised guidelines issued November 3, 1980 by Byline C. Spencer of the Utah Division of Oil, Gas and Mining (UDOGM), and

2) as suggested by the Utah Coal Mining and Reclamation Regulatory Program's, Rules Pertaining to Underground Coal Mining Activities, revised guidelines issued May, 1987 by the Utah Division of Oil, Gas and Mining.

14.2 Legal, Financial, Compliance, and Related Information

Legal, financial, and compliance information contained in Sections 2.1 through 2.9 of the Crandall Canyon Mining and Reclamation Plan applies to state leases ML-21568 and ML-21569. Additional information relating specifically to the above mentioned leases is discussed in this chapter.

The proposed mining area lies in Utah State owned land. The legal owners of the surface rights are listed below.

United States Government
Administered by the United States
Department of Agriculture, Forest Service,
Intermountain Region
Manti-LaSal National Forest
599 West River Drive
Price, Utah 84501

Utah State Government
Administered by the State of Utah
Division of State Lands and Forestry
3 Triad Center, Suite 400
355 West North Temple
Salt Lake City, Utah 84180

Mineral lease agreement documents identifying Genwal Coal Company as the leaseholder of Utah State Leases ML-21568 and ML-21569 are found in Appendix 14-1.

The applicant is applying for a five year permit, commencing from the date of approval. Operations will continue longer than five years if the coal becomes available. Genwal will commit to comply with Utah Coal Mining Regulations R645-301-515.300, R645-301-515.311, and R645-301-515.321 during episodes of temporary and permanent cessation of operations as outlined in Section 3.5.3.

Effluent limitations and monitoring requirements are contained in the current NPDES permit (Appendix 3-8).

Violations cited by the Utah Division of Oil, Gas and Mining that occurred from 1982 through 1987 are found in Appendix 2-2. Violations that occurred during 1988 are listed in Tables 1 and 2 of Appendix 13-2. Mining violations that have occurred in 1990 are found in Table 14-1 (Appendix 14-2).

Newspaper advertisements (Appendix 14-3), in compliance with UMC 786.11(a) requirements, will be published in a local newspaper at least once a week for a period of four consecutive weeks.

14.3 Operation and Reclamation Plan

14.3.1 **Surface Facilities/Construction Plans.** No additional portals, surface buildings, or surface structures will be built as a result of mining in state leases ML-21568 and ML-21569.

Coal handling, processing, preparation, and storage operations to be implemented are identical to those currently in operation and permitted (Section 3.2.4).

Power, water, and sewage systems to be used are those currently permitted and in-place (Sections 3.2.5, 3.2.6, and 3.2.7).

14.3.2 **Operation Plan.** Operation plans to be implemented are identical to those presently permitted/approved and in use (Section 3.3).

14.3.2.1 **Mining Plans.**

14.3.2.1.1 **Projected Development of State Leases ML-21568 and ML-21569.** An underground mine design has been developed and appears in Plate 3-3. Mined areas within both leases are bordered by 100 foot wide barrier pillars. Typical entry-ways are 20 feet wide. Typical pillars are 55 feet wide and 100 feet long, with 75 by 120 foot centers.

Mining will commence with lease ML-21569, and be followed by lease ML-21568. Five entries comprising "west mains" have been designed as a westward extension of the right-of-way into lease ML-21569. West mains extend to within 100 feet of the western edge of lease ML-21569. Four entries comprise both a north-south submain named Main North, and a bleeder called 1st Right. Nine retreat panels, and barrier protection are accessed via 1st Right and Main North. Pilar height (thickness of coal seam) ranges from about 5.5 to 10 feet.

Lease ML-21568 is to be accessed five entries which extend southward from West Mains along the eastern edge of the lease. Five entries, running east-west, extend to the western edge of lease ML-21568, and access 12 panels.

An incidental boundary change (ICB) of 50 acres is included in the North West corner of ML-21569. The ICB is for potential surface effects of mining only. No underground mining will take place within this ICB. A Forest Service Special use permit is in effect for this area.

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Mining will commence with lease ML-21569, and be followed by lease ML-21568. Five entries comprising "west mains" have been designed as a westward extension of the right-of-way into lease ML-21569. West mains extend to within 100 feet of the western edge of lease ML-21569. Four entries comprise both a north-south submain named Main North, and an east-west submain called 5th West. Eight panels, retreat rooms, and barrier protection are accessed via 5th West and Main North. Pilar height (thickness of coal seam) ranges from about 5.5 to 10 feet.

Lease ML-21568 is to be accessed five entries which extend southward from West Mains along the eastern edge of the lease. Five entries, running east-west, extend to the western edge of lease ML-21568, and access 12 panels.

A discussion of coal pillar and roof span design is found in Section 14.6.1.

14.3.2.1.2 Retreat Mining.

Retreat mining in lease ML-21569 will start with the first left panel, progress to the south terminating with the 9th left panel. The bleeder and main North will not be retreat mined. In lease ML-21568 retreat mining will commence with panels 1st right, progress to the North and end with the 12th right panel. The east-west submain will be retreat mined. The north-south submain bleeder will not be retreat mined.

Retreat mining will be limited to 50% extraction within a 20 degree angle-of-draw from the perennial stream channels until either the United States Forest Service grants permission to subside perennial streams, or until geotechnical data is provided by Genwal supporting use of a lesser angle-of-draw, and/or indicating that mine subsidence will have no surface effects. Total retreat mining will not occur beneath the stream channel buffer zones until Genwal has 1) delineated those portions of the stream reaches within the state leases which have perennial flow, (Table 14-4) and 2) shown that these reaches will not be adversely effected by mining activity (Plate 3-3). A 20 degree angle-of-draw was used to delineate the stream channel buffer zones.

Conclusion drawn by the BLM and from TerraTek Inc. support the 20 degree angle of draw and estimate the amount of maximum subsidence (Appendix 14-19).

14.3.2.2 **Waste Disposal Plans.** Waste disposal methods to be used are identical to those currently permitted/approved and in practice (Section 3.3.9).

The method of mining used at the Crandall Canyon Mine results in no development waste. Any rock waste resulting from unexpected roof falls and overcasts is not brought to the surface, but is disposed of along pillar lines or stored in areas that have not been retreat mined and that are not to be retreat mined. The material disposed of along the pillar lines is identical to

A discussion of coal pillar and roof span design is found in Section 14.6.1.

14.3.2.1.2 **Retreat Mining.**

Retreat mining in lease ML-21569 will start with the first right panel, progress eastward terminating with the 8th right panel. Submains 5th West and main North will not be retreat mined. In lease ML-21568 retreat mining will commence with panels 11th right, progress eastward and end with the first right panel. The east-west submain will be retreat mined. The north-south submain will not be retreat mined.

Retreat mining will be limited to 50% extraction within a 20 degree angle-of-draw from the perennial stream channels until either the United States Forest Service grants permission to subside perennial streams, or until geotechnical data is provided by Genwal supporting use of a lesser angle-of-draw, and/or indicating that mine subsidence will have no surface effects. Total retreat mining will not occur beneath the stream channel buffer zones until Genwal has 1) delineated those portions of the stream reaches within the state leases which have perennial flow, (Table 14-4) and 2) shown that these reaches will not be adversely effected by mining activity (Plate 3-3). A 20 degree angle-of-draw was used to delineate the stream channel buffer zones.

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The method of mining used at the Crandall Canyon Mine results in no development waste. Any rock waste resulting from unexpected roof falls and overcasts is not brought to the surface, but is disposed of along pillar lines or stored in areas that have not been retreat mined and that are not to be retreat mined. The material disposed of along the pillar lines is identical to that which naturally caves in during retreat mining, therefore no leachate will be formed other than that associated with normal pillaring. All disposal of this rock waste will be done in compliance with MSHA regulations.

No processing waste is generated at the Crandall Canyon Mine. There exist no partings in the coal mined at the Crandall Canyon Mine. The sole rock type removed from the mine is coal, all of which is trucked off site and sold.

Exploratory drill hole data and mining conditions indicate that no development or processing waste will be produced. However, in the unlikely event either rock, development and/or processing waste is encountered, and the volume of waste generated exceeds the capacity that can be disposed of along pillar lines, Genwal commits to disposing of the waste in a DOGM licensed disposal facility. Genwal will notify and consult with DOGM regarding disposal sites. All disposal operations will be in compliance with Utah Coal Mining Regulations R645-301-536 and R645-301-746.

Sediment pond waste (excess spoil) removed from the pond during cleaning operations will be either 1) returned to the mine workings and disposed of in compliance with MSHA regulations, or 2) hauled directly to a DOGM licensed coal waste disposal facility. Prior to cleaning the sediment pond, representative samples of the sediment will be collected and analyzed for any acid- and/or toxic-forming materials, and the volume of excess spoil to be disposed of will be calculated. If the analytical results exceed the toxic limit, the waste material will be handled and disposed of in compliance with regulations applicable to acid- and/or toxic-forming materials. Following receipt of the analytical results and determining the volume of waste to be disposed of, and prior to cleaning of the sedimentation pond and disposal of the excess spoil, Genwal commits to notifying and consulting with DOGM regarding disposal of the waste 60 days prior to disposal. Disposal of excess spoil will be in compliance with Utah Coal Mining Regulations R645-301-535.100. All moisture and runoff from the pond cleaning will be contained in the pond to minimize runoff and infiltration to the groundwater system, and other environmental damage. Acid- and/or toxic-forming materials will only be disposed of at a facility permitted to accept the specific contaminants present.

Solid waste generated by normal mining activities which include but are not limited to wood, paper, scrap metal and belting, etc., will be disposed of underground along pillar lines in accordance with MSHA regulations. If sufficient space underground is not available solid waste will be brought to the surface and disposed of in a trash container and transported to a state approved landfill for final disposal.

Scrap metal and used equipment will be stored underground or on the surface next to the solid waste container until the material is sold to a scrap metal or used equipment dealer.

Oil contaminated soil from the gas and oil storage area will be removed prior to reclamation or moving of the facility, and disposed of at an approved disposal facility licensed to accept oil/gas contaminated soil. Contaminated soil will be cleaned and disposed of when an area of ten square feet is saturated.

In the unlikely event toxic or hazardous waste is encountered, Genwal will notify and consult with the Division of Oil, Gas, and Mining, as well as the State Health Department; the hazardous or toxic material(s) will be disposed of at a facility permitted to accept the specific contaminants found. No toxic or hazardous substances will be disposed of at a facility not licensed to dispose of the contaminants encountered.

14.3.3 Environmental Protection.

14.3.3.1 Protection of Vegetative Resources.

14.3.3.1.1 Projected Impacts of Mining on Vegetative Resources. Since there are to be no new mine openings, surface structures, or subsidence (Section 14.6.2.1), no impact on vegetative resources is projected.

14.3.3.1.2 Monitoring Procedures. Mapping of the vegetation in T15S-R6E-Sec36 and T16S-R6E-Sec2, as well as in the immediate surrounding environs, was accomplished in detail. Color aerial photographs were taken and used in the field to ground check vegetation types, and as mapping guides in the lab. The area was mapped by walking a portion of the area while mapping the vegetation types directly on the aerial photographs. The aerial photographs were then used to interpolate vegetation communities in areas not negotiated by foot. Helicopter surveys were conducted to enhance mapping of the major vegetation patterns. Vegetation data was then transferred to topographic maps. Plates 14.2 and 14.3 are vegetation maps of T15S-R6E-Sec36 and T16S-R6E-Sec2, respectively. Plate 14.4 is a general vegetation map of the areas adjacent to these two sections.

14.3.3.2 Protection of Fish and Wildlife.

14.3.3.2.1 Projected Impacts of Mining on Fish and Wildlife. Since no surface disturbance is anticipated, no impact on fish and wildlife should occur. Larry Dalton, Division of Wildlife Resources, conducted an inventory of T16S-R6E-Sec2 and T15S-R6E-Sec36 on September 29, 1989 which revealed no raptor cliff nests. The area is of poor quality for cliff nesting raptors (Appendix 13-3).

14.3.3.2.2 Mitigating Measure to be Employed to Protect Fish and Wildlife. Genwal recognizes that the Division of Wildlife Resources and the Utah Division of Oil, Gas & Mining regard all seeps and springs to be important to wildlife. Should any seeps and springs become affected (flow decreased by 50% or more) by mining activity in state leases ML-21568 and ML-21569, Genwal will notify the appropriate agencies and an acceptable mitigation plan will be developed as discussed in Section 3.4.6.2. Effluent limitations set forth in the NPDES Permit regulations (Appendix 3-8) will be complied with.

14.3.3.2.3 Monitoring Procedures. The applicant has committed to report to the regulatory authority the presence of any threatened or endangered species in the area. In the event any threatened or endangered species is observed to move into state lease ML-21568 or ML-21569, Genwal will notify the appropriate agencies and acceptable monitoring and mitigation plans will be developed. Genwal is committed to complying with all monitoring requirements established in the NPDES Permit (Appendix 3-8).

14.3.3.3 Protection of Human Values.

14.3.3.3.1 Projected Impacts of Mining on Human Values, Historical and Cultural. A letter dated November 27, 1989 from James Dykman, Division of State History states:

"no prehistoric or historic sites have been recorded within the project area because no cultural resource surveys have been conducted. However, such sites may well exist in the project area." (Appendix 14-4).

A cultural resource survey was conducted in October 1988 by Les Wilke, Archeologist, Manti-LaSal National Forest (Appendix 5-6), in permit areas UO-54762 and a portion of SL-062648. Wilke found no cultural resources in the most-likely locations, and concluded that the remainder of the lease areas should have no cultural resources. Cultural resources present in the region generally lie near canyon bottoms adjacent to stream beds (Section 5). The majority of the area within leases ML-21568 and ML-21569 lie above stream beds. Therefore, Genwal determines there is at best only a low potential for historical resources existing in these two state leases.

As a result of: 1) the low potential for historical resources existing in leases ML-21568 and ML-21569, and 2) no anticipated surface disturbance, Genwal has determined that no impact on possible human value sites should occur. Consequently, there is insufficient evidence to warrant a field survey to identify possible historic sites in these two leases.

14.3.4 Reclamation Plan.

14.3.4.1 Sealing of Mine Openings.

No new portals to the surface will result from mining of leases ML-21568 and ML-21569. Currently, only one exploration borehole, DH-7 (NVP-7), intersects the proposed mined area (Figures 13-5 and 13-6). Well DH-7 was abandoned in compliance with UMC regulations. Any future wells that intersect the proposed mined area will be abandoned in compliance with R645-301-631, R645-301-631.100, and R645-301-631.200 regulations.

14.4 Geology

14.4.1 Regional Geology and Geology of Leases ML-21568 and ML-21569. A detailed discussion of the regional geologic framework, and the geology (stratigraphy and structure) present at the Crandall Canyon Mine appears in Chapter 6. Stratigraphic sections, geologic maps, drilling results, and geochemical results are also found in Chapter 6. A lithologic log of the strata (North Horn, Price River, Castlegate, Blackhawk, and Star Point Formations) encountered in exploration well DH-7 (confidential) appears in Appendix 14-5.

The geologic conditions (stratigraphy, lithology, and structure) present at the Crandall Canyon mine are very similar to those present at the Trail Mountain Mine located only ten miles to the south and reported by Lines (1985).

The coal-bearing unit at both mines is the Upper Cretaceous Blackhawk Formation. The Blackhawk Formation is composed of grey sandstone, siltstone, shale, and coal; it is composed of about 50% fine-grained sandstone at both mines, and is present in roughly equal thicknesses (650 to 1000 feet at Crandall Canyon, and 800 to 1100 feet at Trail Mountain)(Lines, 1985; Chapter 6; Appendix 14-5). The Hiawatha coal bed is the thickest coal bed present at both mines (up to 12 feet at Trail Mountain, and 10 feet at Crandall Canyon), and is found near the base of the Blackhawk (Lines, 1985; Appendix 14-5).

The Upper Cretaceous Star Point Formation of Cretaceous age underlies the Blackhawk Formation at both mines. It is predominately composed of massive tan medium-grained sandstone with minor interbeds of shale and siltstone near its base. This formation outcrops east of the Crandall Canyon Mine and reaches a thickness of 350 to 450 feet. At the southeast end of Trail Mountain, where the Star Point is exposed, it is about 500 feet thick (Lines, 1985). This formation is of significance since it and the saturated portions of the Blackhawk Formation comprise a regional aquifer present at both mine sites.

The Upper Cretaceous Castlegate Formation overlies the Blackhawk Formation and is dominated by massive tan medium-grained massive sandstone. It has a thickness of about 170 to 200 feet at Trail Mountain, and is 250 feet thick at Crandall Canyon (Lines, 1985; Appendix 14-5).

The Castlegate is overlain by the Upper Cretaceous Price River Formation, a grey medium- to coarse-grained sandstone interbedded with several thin shale beds at both mine sites. The Price River is about 700 feet thick at the Trail Mountain Mine (Lines, 1985), and is about 600 feet thick at the Crandall Canyon Mine (Appendix 14-5).

Overlying the Castlegate is the North Horn Formation of Upper Cretaceous and Tertiary age. It is composed of interbedded shales, siltstones, sandstones, and limestones. At the Trail Mountain mine it reaches a thickness of about 1000 feet, thickness of only several hundred feet are present at Genwal due to erosion. The North Horn Formation caps the mountain ridges in the Crandall Canyon area, and serves as a recharge unit to underlying formations as well as supplying water to springs within the formation.

The Joes Valley fault breaks the continuity of these geologic units at both the Trail Mountain and Crandall Canyon Mines. The Joes Valley fault lies along the west edge of Trail Mountain, and along the west edge of East Mountain at the Crandall Canyon Mine (Davis and Doelling, 1977). The Joes Valley fault forms the eastern fault boundary of a graben about 2 miles wide, that extends both north and south of both mines (Davis and Doelling, 1977). Davis and Doelling (1977) estimate approximately 2300 feet of vertical displacement along the fault in this area. Stratigraphic dip at both mine sites is very small, only about 2 to 3 degrees (Lines, 1985; Section 14.5.1.4).

14.4.2 **Rock Characteristics of Coal and Adjacent Units.** Chemical analyses of the coal seam, and the strata immediately above and below in the areas that have been mined and that are currently being mined have been conducted (Sections 6.3, 6.4, 6.4.1, 6.4.2, 6.5.5.2, and Appendix 6-2).

Geochemical analyses of State Leases ML-21568 and ML-21569 will be conducted in compliance with the UDOGM's Guidelines For Underground and Surface Coal Mining, revised April, 1988. The following analyses of the Hiawatha coal seam and the immediate over- and underlying strata will be conducted: Ph, electrical conductivity, particle size (texture), sodium absorption ratio, non-sulfate sulfur percent, selenium, total N, boron, maximum acid and neutralization potentials, organic carbon, as well as soluble Ca, Mg, and Na. Specific sample analysis methods suggested in Table 6 of the above referenced UDOGM guideline will be utilized. Samples will be collected and analyses run at the time of commencement of mining operations, as lithologic/hydrologic conditions change during mining operations, and as directed by the UDOGM.

14.4.3 Geologic Effects On Mining. Discussions of mining hazards, surface hazards, and impacts of mining appear in Section 6.6.

14.5 Hydrology

14.5.1 Groundwater Hydrology.

14.5.1.1 Methodology and Regional Groundwater Hydrology. Seep and spring survey methodology, and the regional groundwater hydrology are outlined in Sections 7.1.1 and 7.1.2.1 respectively.

14.5.1.2 State Leases ML-21568 and ML-21569 Plan Area Aquifers. Hydrologic characteristics of the North Horn, Price River, Castlegate, and Blackhawk Formations are reviewed in Section 7.1.2.2. Locations of seeps and springs monitored during 1985, 1987, 1989, and 1990 are shown in Figure 14-2. The geologic occurrence and use of seeps and springs is found in Appendix 14-6. Flow rate and temperature measurements appear in Appendix 14-7. Specific conductivity and Ph measurements are found in Appendices 14-8 and 14-9, respectively. Field water-quality measurements are summarized in Appendix 14-10.

Approximately 60% of all the seeps and springs found during the early-season surveys had flows of one gallon per minute or less (Appendix 14-7). These flows typically decreased by the time of the late-season surveys, with most of the low-flow sources issuing only as seeps or being dry. The majority of seeps and springs issue from bedding planes separating porous sandstones or fractured zones from underlying low-permeability siltstone and shale beds.

The occurrence of groundwater at Trail Mountain (Lines, 1985) is very similar to that at Crandall Canyon. The major water bearing unit at both mines is the regional Blackhawk-Starpoint aquifer. The Trail Mountain Mine is overlain by perched aquifers in the Blackhawk, Castlegate, Price River, and North Horn Formations; these perched aquifers are separated by unsaturated zones (Lines, 1985). Seep and spring survey results at Crandall Creek also reveal the presence of perched aquifers in the same formations. As at Trail Mountain, this perching occurs where more-permeable strata overlie less-permeable strata (Lines, 1985; Appendix 14-6).

The distribution of seeps and springs among the formations present at both the Trail Mountain (Lines, 1985) and Crandall Canyon (Appendix 14-6) mines is very similar. At both mines the largest percentage of seeps and springs are found in the North Horn and Price River Formations. In the Crandall Canyon Mine area 40% of all seeps and springs emit from the North Horn Formation, and 42% emit from the Price River Formation. At Trail Mountain, 55% of all seeps and springs are found in the North Horn, and 29% are present in the Price River Formation. The Blackhawk Formation accounts for only 12% of the seeps and springs at Crandall Canyon, and only 7% at Trail Mountain. Similarly, in both mine areas the smallest percentage of seeps and springs are found in the Castlegate Formation; only 9% were found emitting from the Castlegate at Trail mountain, and only 6% were found at Crandall Canyon. The relative percentage of seeps and springs found at the Crandall Canyon mine are corrected for those monitored in the alluvial valley floor deposits - principally Joes Valley Fault Graben.

The low flow rates from most of the seeps and springs emitting from the Blackhawk Formation (Appendices 14-6 and 14-7) result from the low hydraulic conductivity of the formation where it remains unfractured. Laboratory permeability data from a core sample taken in T17S-R6E-Sec27 at Trail Mountain indicate an average horizontal hydraulic conductivity of $1.3x10^{-2}$ feet per day,

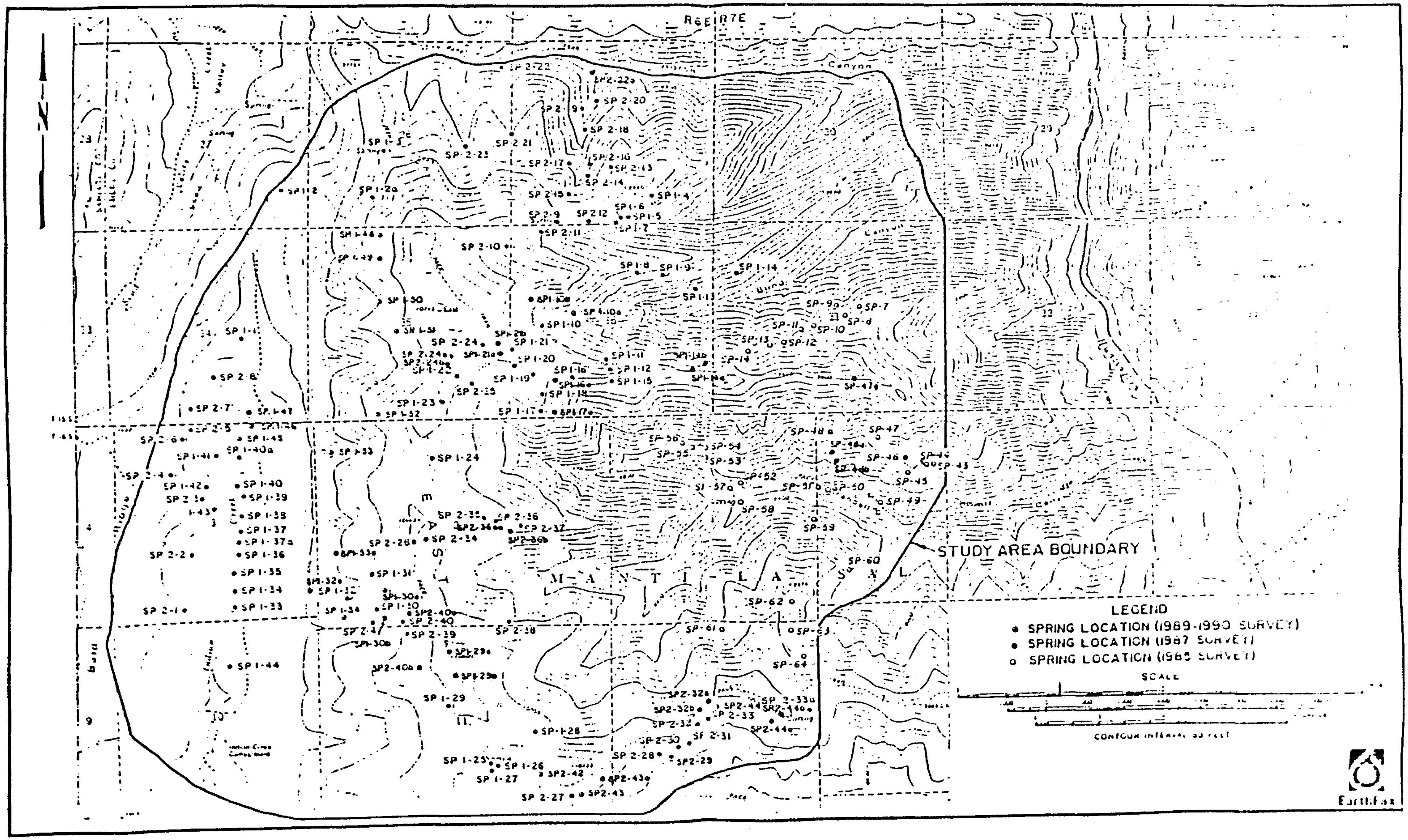


FIGURE 14-2. SEEP AND SPRING LOCATIONS IN NEICO STATE LEASES ML-21568 AND ML-21569 AND SURROUNDING AREAS.

and an average vertical hydraulic conductivity of 3.8×10^{-3} feet per day for sandstone units of the Blackhawk Formation (Lines, 1985). Shale and siltstone samples of the Blackhawk Formation have maximum horizontal and vertical hydraulic conductivities of only 1.0×10^{-7} and 1.2×10^{-6} feet per day, respectively (Lines, 1985). These low hydraulic conductivities of the shales and siltstones indicate that these finer-grained sediments within the Blackhawk serve as barriers to the downward migration of water. As a result, water recharge into the Blackhawk, either from adjacent formations, snow melt, or rainfall, is allowed to percolate vertically through sandstone beds until a siltstone/shale bed is encountered at which time the water is forced to travel laterally along the bedding plane to the surface. Similarly, the majority of the seeps and springs in the Castlegate, Star Point and North Horn Formations observed in the field surveys in Crandall Canyon also issue from bedding planes. Due to the presence of these vertical permeability barriers, the aquifers in the North Horn, Price River, Castlegate, as well as in the upper portions of the Blackhawk Formations are perched, with no direct communication to the underlying regional Blackhawk-Star Point aquifer. Consequently, dewatering of the Blackhawk-Star Point aquifer resulting from mining the Hiawatha Coal of the Blackhawk Formation has little potential of affecting seeps and springs in the area (Lines, 1985).

All seeps and springs in T15S-R6E-Sec36 (Lease ML-21569), as well as those in surrounding sections, to the west in T15S-R6E-Sec35, east in T15S-R7E-Sec31, north in T15S-R6E-Sec25, and northwest in T15S-R6E-Sec26 (Figure 14-2), principally drain aquifers in the North Horn and Price River Formations (Appendix 14-6). These aquifers lie 470 to 2410 feet above the top of the Hiawatha Coal Seam, are found along bedding planes and appear perched with no direct hydraulic connection to the potential mine workings in the Hiawatha coal bed. As a result, mine dewatering is anticipated to have minimal, if any affects on these seeps and springs.

Similarly, seeps and springs in T16S-6E-Sec2 (Lease ML-21568), as well as those in surrounding sections, to the south in T16S-R6E-Sec11, and to the southeast in T16S-R6E-Sec12 (Appendix 14-6), drain aquifers in the North Horn and Price River Formations. These perched aquifers lie 1380 to 2150 feet above the top of the Hiawatha Coal Seam, and do not appear to be in hydraulic communication with the potential mine workings in the Hiawatha. Hence, there exists only a minimal likelihood that these seeps and springs would be affected by mine dewatering.

Seeps and springs east of lease ML-21568, in T16S-R6E-Sec1 (Figure 14-2), emit water from the Blackhawk Formation (Appendix 14-6). The elevations of these seeps and springs lie 420 to 700 feet above the potentiometric surface of the regional Blackhawk-Star Point aquifer. These seeps and springs appear to also be discharging from perched aquifers. With no direct communication to the underlying regional aquifer these water sources should not be affected by mine dewatering.

Seeps and springs to the northwest of Lease ML-21568 in T15S-R6E-Sec34, to the west in T16S-R6E-Sec3, and to the southwest in T16S-R6E-Sec10 (Figure 14-2), discharge from the North Horn Formation, or alluvium covering the North Horn Formation in Little Joes Valley. In contrast to other seeps and springs in the study area, flows from these water sources increased substantially between the July and October 1987 surveys (Appendix 14-7). This anomalous water flow trend is attributed to three factors. First, recharge from the Joes Valley Fault Zone. These water sources lie in a linear trend parallel to the fault zone, directly along or to the west of Indian Creek which also follows the trace of the fault zone. Secondly, recharge from water in the colluvium and alluvium on the west-facing slope of East Mountain flows downhill toward Little Joes Valley and discharges into the valley alluvium. The relatively late arrival of this water is due to the lag time as this snow melt-derived water travels through the soil to the valley floor. Thirdly, these seeps and springs in Little Joes Valley lie in a different drainage basin than those in the rest of the study area, a drainage basin which is displaying a contrasting flow pattern to that present in the Huntington Creek tributaries on the east-facing slopes of East Mountain.

14.5.1.3 Groundwater Development and Mine Dewatering.

14.5.1.3.1 Water Supply. Table 14-2 contains a listing of groundwater rights (and their associated seeps and springs) in and adjacent to State Leases ML-21568 and ML-21569. This data was obtained from the files of the

Utah Division of Water Rights in June 1990. More in-depth information concerning these rights is contained in Appendix 14-11. Locations of these water rights are denoted in Figure 14-3. Table 14-2 also shows what groundwater right corresponds to the seeps and springs observed in the field inventories.

No sign of current use by stock animals has been observed during the seep and spring inventories. Apparently, the use of these water rights has been curtailed.

14.5.1.3.2 **Mine Dewatering**. Present inflow into all of the Crandall Canyon mine workings total no more than 100 gallons per minute. The vast majority of this inflow is occurring in the old mine workings (Leases UO-54762 and SL-062648). Only negligible mine inflow has been encountered in the right-of-way and State Lease ML-21569. Currently, water used in mining operations is being pumped to State Lease SL-21569 from the sump in the old mine workings. All inflow water is used in underground mining operations.

14.5.1.4 **Effects of Mining Operation on Groundwater**. Mine dewatering (resulting in removal of water from the aquifers) is the primary mechanism by which the groundwater system may be impacted. As previously stated, it is believed that the water emitting from seeps and springs in State Leases ML-21568 and ML-21569, as well as in the surrounding areas, originate from perched aquifers with no direct communication with the regional Blackhawk-Star Point aquifer. Thus, dewatering resulting from mining the Hiawatha Coal of the Blackhawk Formation has little potential for impact. This observation is in agreement with conditions present at Trail Mountain as reported by Lines (1985).

As previously stated, average horizontal and vertical hydraulic conductivities of 1.3×10^{-2} and 3.8×10^{-3} feet per day, respectively, are present in sandstones of the Blackhawk Formation (Lines, 1985). Blackhawk shales and siltstones have maximum horizontal and vertical hydraulic conductivities of 1.0×10^{-7} and 1.2×10^{-6} feet per day, respectively (Lines, 1985). Lines (1985) also reports maximum horizontal and vertical hydraulic conductivities for the Star Point Sandstone of 3.1×10^{-2} and 1.1×10^{-2} feet per day, respectively.

TABLE 14-2. Groundwater rights in Neico State Leases ML-21568 and ML-21569 Plan, and Adjacent Areas

W.U. Claim No.	Owner	Flow [cfs] Claim/ Allotment	Use	Period of Use	Source	Seep/ Spring No.
93-624	U.S. Forest Serv.	.011(a)	Stockwater	July 6 to Sept 25	Spring	NF
93-1176	U.S. Forest Serv.	.015(a)	Stockwater	July 6 to Sept 25	Spring	SP 1-3
93-1403	U.S. Forest Serv.	.011(a)	Stockwater	July 6 to Sept 25	Spring	SP 2-14
93-1404	U.S. Forest Serv.	.011(a)	Stockwater	July 6 to Sept 25	Spring	SP 2-9
93-1406	U.S. Forest Serv.	.011(a)	Stockwater	July 6 to Sept 25	Spring	SP 2-31
93-1407	U.S. Forest Serv.	.011(a)	Stockwater	July 6 to Sept 25	Spring	SP-47a
93-1408	U.S. Forest Serv.	.011(a)	Stockwater	July 6 to Sept 25	Spring	SP-47
93-1409	U.S. Forest Serv.	.011(a)	Stockwater	July 6 to Sept 25	Spring	SP-58
93-1410	U.S. Forest Serv.	.011(b)	Stockwater	July 1 to Sept 30	Spring	SP 1-29
93-1572	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	NF
93-1573	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-44
93-1574	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	NF
93-1575	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-33

Table 14-2 (cont.). Groundwater rights in Neico State Leases ML-21568 and ML-21569 Plan, and Adjacent Areas

W.U. Claim No.	Owner	Flow [cfs] Claim/ Allotment	Use	Period of Use	Source	Seep/ Spring No.
93-1576	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 2-2
93-1577	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-34
93-1578	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-35
93-1579	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-36
93-1580	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-32a
93-1581	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-37
93-1582	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-38
93-1583	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-43
93-1584	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-39
93-1585	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-40
93-1586	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-40a
93-1587	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-45
93-1588	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-47
93-1589	U.S. Forest Serv.	.011(c)	Stockwater	June 21 to Sept 20	Spring	SP 1-46

Table 14-2 (cont.). Groundwater rights in Neico State Leases ML-21568 and ML-21569 Plan, and Adjacent Areas

W.U. Claim No.	Owner	Flow [cfs] Claim/ Allotment	Use	Period of Use	Source	Seep/ Spring No.
93-1639	U.S. Forest Serv.	.011(d)	Stockwater	June 6 to Sept 30	Spring	NF
93-1640	U.S. Forest Serv.	.011(d)	Stockwater	June 6 to Sept 30	Spring	NF
93-1641	U.S. Forest Serv.	.011(d)	Stockwater	June 6 to Sept 30	Spring	NF
93-1642	U.S. Forest Serv.	.011(d)	Stockwater	June 6 to Sept 30	Spring	SP 2-3
93-1643	U.S. Forest Serv.	.011(d)	Stockwater	June 6 to Sept 30	Spring	SP 2-6
93-1644	U.S. Forest Serv.	.011(d)	Stockwater	June 6 to Sept 30	Spring	SP 2-7

(a) Part of water rights WUC 93-175, -183, -191, -336, -378, -483, -606, -623, -1176, -1403, -1404, -1406, -1407, 1408, and -1409 on Crandall Canyon Allotment
(b) Part of water right WUC 93-198 on Crandall Ridge Allotment
(c) Part of water right WUC 93-1588 on Trail Mountain Allotment
(d) Part of water right WUC 93-1673 on Joes Valley Allotment
NF Not found

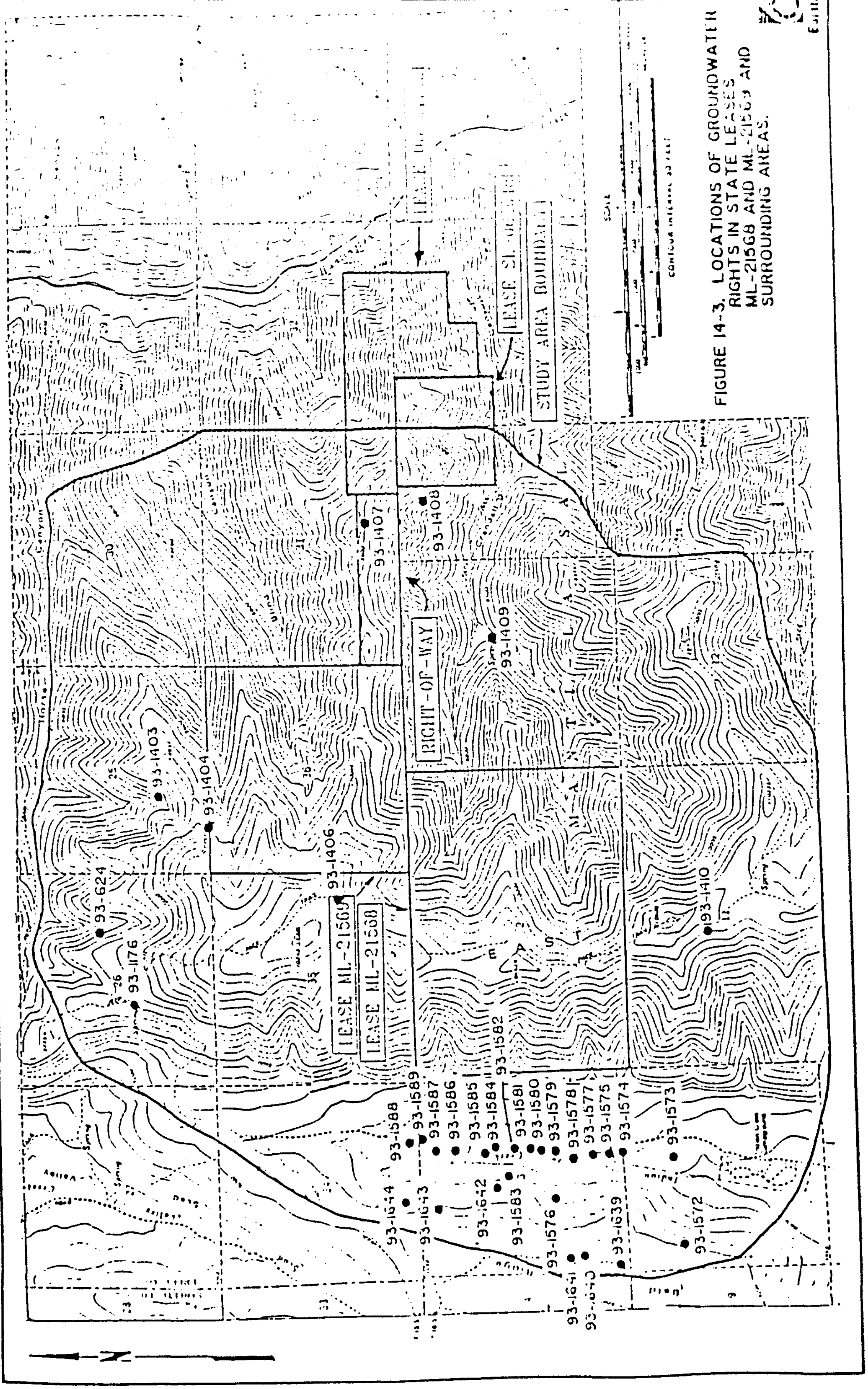


FIGURE 14-3. LOCATIONS OF GROUNDWATER RIGHTS IN STATE LEASES ML-21568 AND ML-21569 AND SURROUNDING AREAS.

A slug test performed in MW-1 in Crandall Canyon (Figure 7-4) revealed a hydraulic conductivity of 0.1 foot per day for the Star Point Sandstone (section 7.1.2.2). This value translates to a transmissivity of 4.5 square feet per day, similar to those reported by Lines (1985) at Trail Mountain.

A map of the potentiometric surface of the Blackhawk-Star Point aquifer in Crandall Canyon appears in Figure 14-4. The horizontal hydraulic gradient is 0.12 foot per foot. This mapped area of the potentiometric surface underlies the steep south-facing slope of Crandall Canyon (compare with Figure 14-3). Hence, this horizontal hydraulic gradient can be regarded as high for the Crandall Canyon area as a whole. Due to the topographic elevation of the Hiawatha Coal Seam in Leases ML-21568 and ML-21569 the mine workings will be in the saturated portion of the Blackhawk-Star Point aquifer (compare Figures 14-4 and 14-5). As a result, groundwater inflow at the Crandall Canyon Mine is expected.

Estimates of groundwater inflow into the Crandall Canyon mine are based on modeling results of Lines (1985) obtained from study of the identical regional Blackhawk-Star Point aquifer system at Trail Mountain. Lines used a finite-dimensional computer model developed by McDonald and Harbaugh (1984) to obtain order-of-magnitude estimates of potential mine inflow resulting from mine dewatering.

Mine inflow rates in leases ML-21568 and ML-21569 are estimated using Figure 14-6. The graph appearing in Figure 14-6 uses hydraulic conductivities of 0.01 and 0.02 foot per day for the Blackhawk and Star Point Formations, respectively. To evaluate the accuracy of these curves in predicting inflow into the above mentioned leases, the amount of water currently entering the present mine workings in areas below the potentiometric surface of the regional Blackhawk-Star Point aquifer were compared to that predicted in Figure 14-6. The area presently beneath the potentiometric surface is about 3000 feet in length and 1500 feet in width (compare Figures 14-4 and 14-5). The family of curves (Figure 14-6) with a horizontal hydraulic gradient (I) of 0.098 were used, since this hydraulic gradient value agrees closely with that measured at Crandall Canyon (I = 0.12). The predicted inflow of 0.33 cfs (148 gpm) is above the present-day observed inflow of 100 gpm. As a result, predictions of mine inflow

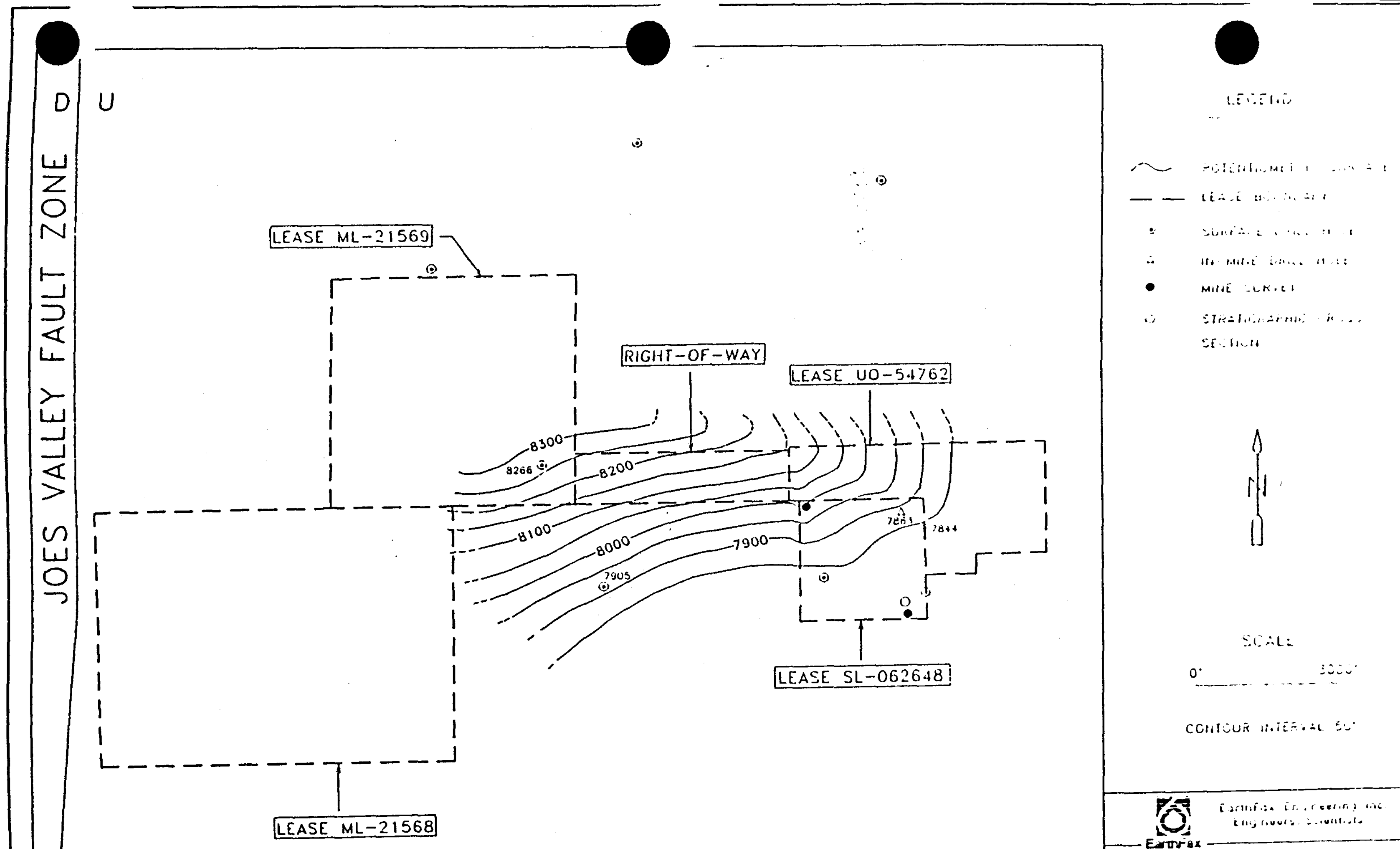
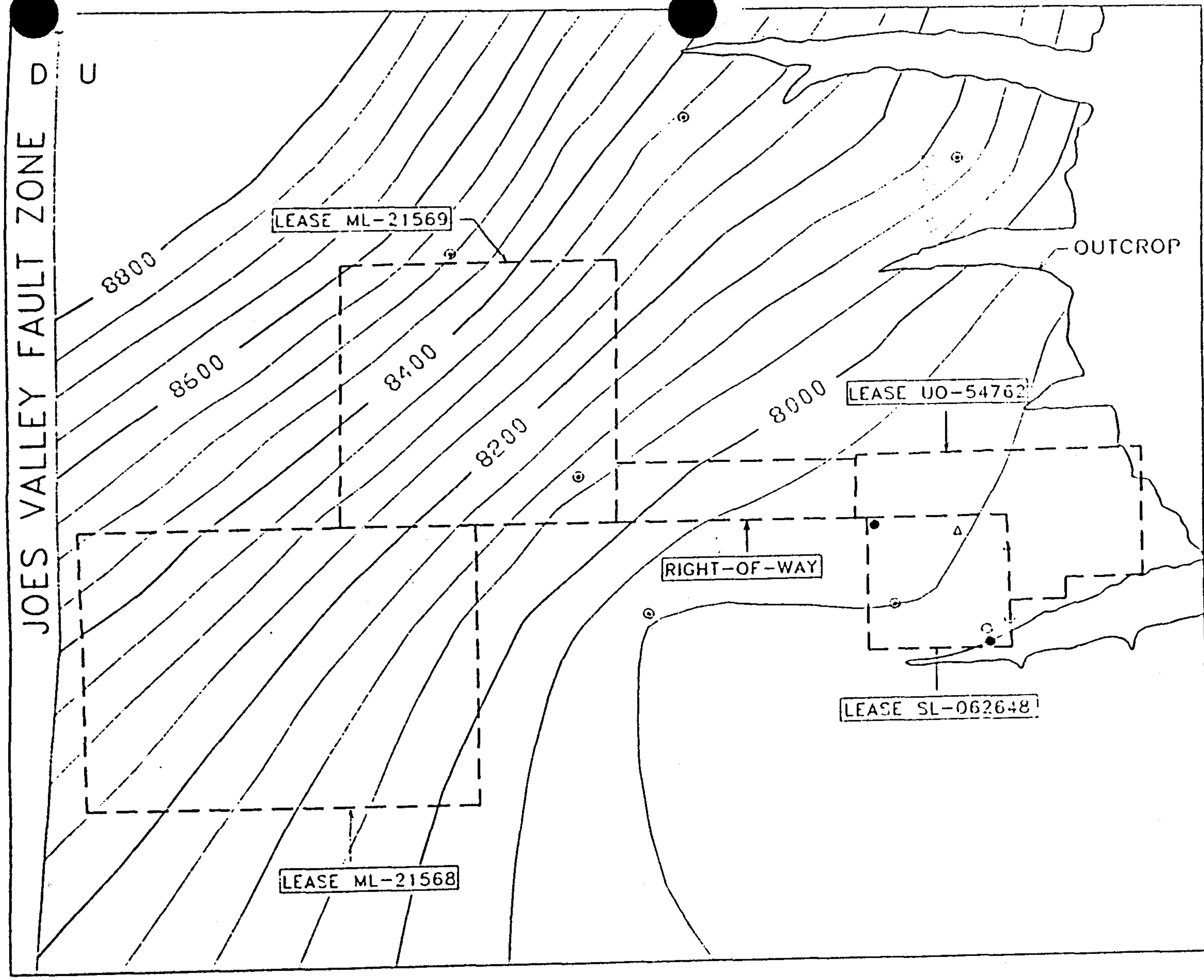


FIGURE 14-4.
POTENTIOMETRIC
SURFACE MAP OF
BLACKHAWK-STAR POINT
AQUIFER



LEGEND

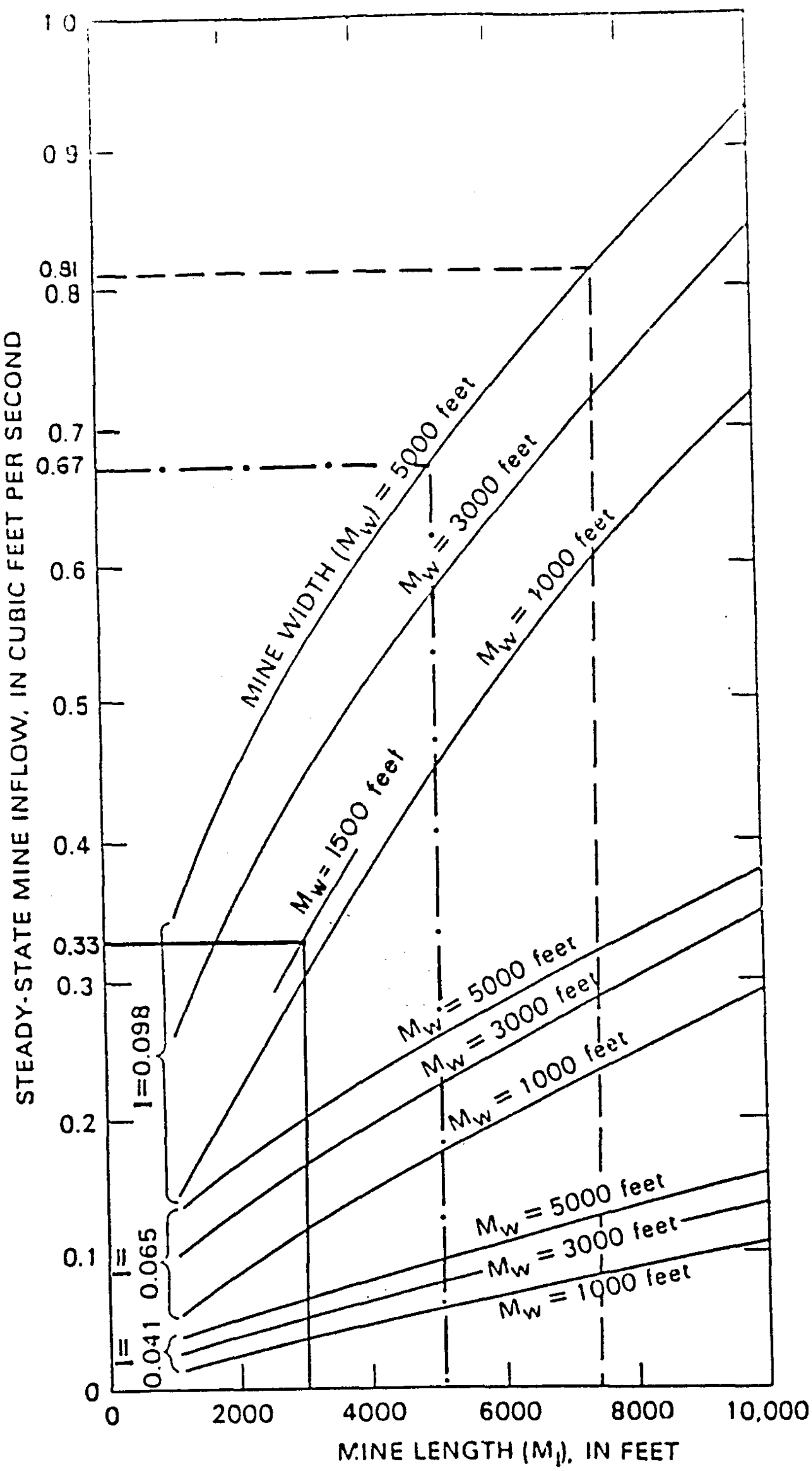
SCALE

0' 3000'

CONTOUR INTERVAL 50'

Earthfax Engineering Inc
Engineers/Scientists

FIGURE 14-5.
STRUCTURE CONTOUR MAP
OF TOP OF HIAWATHA
COAL SEAM



SOURCE: LINES (1985)

—— PRESENT MINE AREA

— — LEASE ML-21568

— · — LEASE ML-21569

FIGURE 14-6. PROJECTED GROUNDWATER INFLOW INTO THE NEICO STATE LEASES ML-21568 AND ML-21569 PROPOSED MINE WORKINGS.

EarthFax

rates to be experienced in Leases ML-21568 and ML-21569 obtained from Figure 14-6 can be regarded as high limits.

Lease ML-21568 has a total mine width and length of 5400 and 7400 feet, respectively (Plate 14-1). The proposed mine area within lease ML-21569 has a total width of 4880 feet and length of 5160 feet (Plate 14-1). The curve corresponding to a mine width of 5000 feet in Figure 14-6 is used in estimating inflow for both leases. Estimated inflow into Lease ML-21568 is 0.81 cfs (364 gpm); inflow into Lease ML-21569 is estimated to be 0.67 cfs (300 gpm)(Figure 14-6). Since these estimates are for fully-developed mine areas, inflows to be experienced during mining operations are expected to be lower, and progressively increase during development of the mine workings. The emplacement of the majority of the mine inflows are anticipated to be encountered in gob sections near the working face of the mine.

As previously mentioned, present mine inflow is considerably less than that predicted. Negligible mine inflow in the Right-of-Way and Lease ML-21569 indicate the potentiometric surface may lie below the Hiawatha Coal bed. This observation is contradictory to the potentiometric surface elevation projected into the State Leases from monitoring well data collected in Leases UO-54762 and SL-162648. To more accurately predict mine inflow rates, and effects on the regional Blackhawk-Star Point aquifer two in-mine groundwater monitoring wells will be drilled in State Lease ML-21569. These wells will enable more accurate determination of the potentiometric surface, hydraulic gradient, and projected mine inflow rates in the state leases. The effects of mining on groundwater will be revaluated and Chapter 14 modified.

14.5.1.5 Mitigation and Control Plan. Based on information presented in the preceding section, only minimal impacts on groundwater resources in the vicinity of Leases ML-21568 and ML-21569 may result.

Should it be necessary to develop alternate water supplies due to unexpected diminution or interruption of flows as a direct result of mining activities, the applicant will contact the Utah Division of Wildlife Resources and develop plans to replace water supplies in quantity and quality, on a case-by-case basis. This would be augmented with water currently owned by Genwal Company, and would be a 1 to 1 replacement through wells and diverting underground flows and or other mitigation as to discusions with UDWR.

Currently, treatment of mine water prior to discharge into Crandall Creek includes use of one underground sump (Section 7.2.3.2). Discharge to Crandall Creek has occurred only 3 times in the last 5 years (NPDES Permit - Appendix 3-8).

Current mine inflow totals approximately 100 gpm. An underground water budget (January 15, 1991) appears in Appendix 14-12. Current (1990) use of mine inflow is 7.6 gpm. Projected use of mine inflow in State Leases ML-21568 and ML-21569 is 7.9 gpm. The quantity of mine inflow that is lost to evaporation and infiltration are estimates based on experience at other mines, and the infrequent need to discharge into Crandall Creek. The quantity of mine inflow that will exit the mine via evaporation is likely greater than the present value.

Although worst-case estimates of mine inflow in the state leases are greater than the present inflow rate, the actual inflow rate to be encountered is unknown. In order to effectively treat mine inflow an additional sump and pump house will be built in the southeastern corner of Lease ML-21569 (Appendix 14-13). This new sump will be equipped with a Worthington pump capable of pumping 150 gpm at 400 psi. This proposed sump will serve as the primary treatment facility for mine inflow, as well as the active water supply for mining operations. The existing sump will be maintained as a secondary water treatment facility. If discharge is required, water to be discharged will be initially treated in the proposed sump in Lease ML-21569, then pumped to the secondary (presently existing) sump, prior to discharge into Crandall Creek.

In the event mine inflow rates exceed the capacity of these treatment facilities to treat the mine inflow to meet the discharge limit criteria outlined in the NPDES Permit, Genwal commits to modifying these treatment facilities and/or constructing additional facilities in order to ensure compliance with the NPDES Permit. Treatment facilities to be considered include enlargement and/or construction of additional underground sumps and/or surface settling ponds. If excessive water volumes are encountered the use of flocculants and gel-logs will be considered as stopgap measures until more permanent treatment facilities are in-place.

14.5.1.6 **Groundwater Monitoring Plan.** Groundwater monitoring for Leases ML-21568 and ML-21569 and the surrounding area will include collection of water quality and quantity data from spring SP 2-24 (water right 93-1406) and SP 2-9 (water right 93-1404)(Figure 14-3). These water sources were chosen since water rights have been filed for these springs with the U.S. Forest Service (Table 14-2), and they fall within the maximum limit of possible subsidence (Section 14.6.2.1). Samples will be preserved and analyzed according to procedures outlined in Section 7.1.6. Appendix 13-6 contains an example of the water sampling field report forms to be used.

Quarterly inventories identifying the location and geologic occurrence of mine inflows that exceed three gallons per minute will be conducted. Specific inflows will be selected for continued monitoring in consultation with the UDOGM. Inflow samples will be collected quarterly and analyzed according to Table 7-4. Samples collected during the low-flow period (normally the 4th quarter) will be analyzed according to Table 7-5 when initially encountered, in the years 1995, 2000, 2005, and at 5-year intervals thereafter during the operational period of the mine. This schedule was chosen to maintain sampling consistency with the inflow points presently being monitored (Section 7.1.6).

14.5.2 Surface water Hydrology.

14.5.2.1 Methodology and Existing Surface Water Resources.

Detailed discussions of the methodology of investigation, and existing surface water resources are found in Sections 7.2.1 and 7.2.2 respectively.

14.5.2.2 **Surface Water Development and Control.**

14.5.2.2.1 **Water Supply.** Table 14-3 contains a listing of surface water rights in the plan area as well as areas adjacent to Leases ML-21568 and ML-21569. This data was obtained from the files of the Utah Division of Water Rights in June 1990. More in-depth data pertaining to these water rights is found in Appendix 14-11. Locations of these surface water rights are denoted in Figure 14-7.

All surface rights are held by the U.S. Forest Service or the State of Utah Division of State Lands and Forestry for stockwatering purposes. However, during the seep and spring surveys (June 1985, October 1985, July 1987, October 1987, October 1989, June 1990) no signs of stock usage of these surface water rights were observed. Although the rights exist, usage is apparently curtailed.

14.5.2.2.2 **Runoff- and Sediment-Control Facilities.** A detailed discussion of runoff- and sediment-control facilities consisting of: sedimentation pond and dam, primary and emergency spillways (riprap, bed material, and filter blanket), and boulder-covered slope is found in Section 7.2.3.2 (see also Appendices 7-4, 7-5, 7-6, and 7-7).

14.5.2.3 **Effects of Mining on Surface Water.** Runoff- and sediment-control facilities discussed in Section 7.2.3.2 were designed to safely and effectively convey and control runoff from the specified storm events. As a result, sediment yields in the permit area will be minimized.

No retreat mining will be conducted within the stream channel buffer zones of both the south and north forks of Crandall Creek, Blind Creek, and the south fork of Horse Creek until Genwal has shown what reaches of these streams of perennial, and that these reaches will not be adversely effected by mining activity (Plate 14-1).

14.5.2.4 **Mitigation and Control Plans.** The forenamed runoff- and sediment control facilities, designed to protect and mitigate potential impacts to the surface hydrologic balance of the area, will be subject to quarterly

Table 14-3. Surface water rights in Neico State Leases ML-21568 and ML-21569 plan, and adjacent areas.

W.U. Claim No.	Owner	Claim/ Allotment	Use	Period of Use	Source
93-175	U.S. Forest Service	(a)	Stockwater	July 6 to Sept 25	Stream
93-181	U.S. Forest Service	(b)	Stockwater	July 1 to Aug 30	Stream
93-183	U.S. Forest Service	(a)	Stockwater	July 6 to Aug 25	Stream
93-184	UT State Lands & Forestry	(c)	Stockwater	Jan 1 to Dec 31	Stream
93-190	U.S. Forest Service	(d)	Stockwater	June 21 to Sept 30	Stream
93-191	U.S. Forest Service	(a)	Stockwater	July 6 to Sept 25	Stream
93-198	U.S. Forest Service	(e)	Stockwater	July 1 to Sept 30	Stream
93-258	UT State Lands & Forestry	(c)	Stockwater	Jan 1 to Dec 31	Stream
93-336	U.S. Forest Service	(a)	Stockwater	July 6 to Sept 25	Stream
93-377	U.S. Forest Service	(f)	Stockwater	June 1 to Sept 30	Stream
93-383	UT State Lands & Forestry	(c)	Stockwater	Jan 1 to Dec 31	Stream
93-483	U.S. Forest Service	(a)	Stockwater	July 6 to Sept 25	Stream

Table 14-3 (cont.). Surface water rights in Neico State Leases ML-21568 and ML-21569 plan, and adjacent areas.

W.U. Claim No.	Owner	Claim/ Allotment	Use	Period of Use	Source
93-606	U.S. Forest Service	(a)	Stockwater	July 6 to Sept 25	Stream
93-1180	U.S. Forest Service	(d)	Stockwater	June 21 to Sept 30	Stream
93-1590	U.S. Forest Service	(g)	Stockwater	June 21 to Sept 20	Stream
93-1673	U.S. Forest Service	(h)	Stockwater	June 6 to Sept 30	Stream

(a) Part of water right WUC 93-1403 on Crandall Canyon Allotment
(b) Part of water right WUC 93-507 on Horse Creek Allotment
(c) Part of water right WUC 93-500
(d) Part of water right WUC 93-116 on Gentry Mountain Allotment
(e) Part of water rights WUC 93-193, -198, -201, -1410, -1411, -1412, -1413, and -1414 on Crandall Canyon Allotment
(f) Part of water right WUC 93-377 on Little Joes Valley Allotment
(g) Part of water right WUC 93-1588 on Trail Mountain Allotment
(h) Part of water rights WUC 93-985, -1632, and -1677 on Joes Valley Allotment

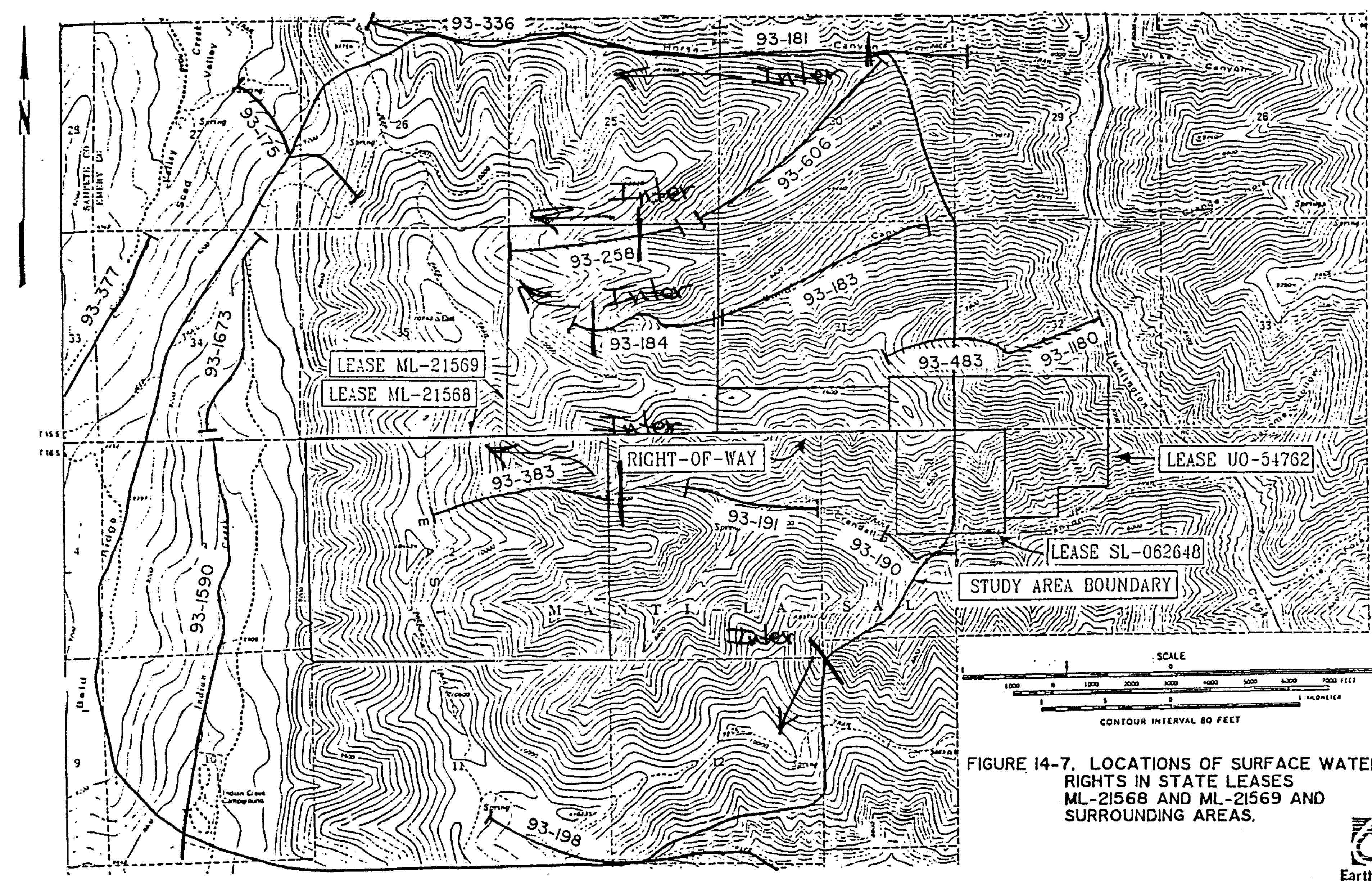


FIGURE 14-7. LOCATIONS OF SURFACE WATER RIGHTS IN STATE LEASES ML-21568 AND ML-21569 AND SURROUNDING AREAS.

inspections to ensure continual effective operation. Necessary repairs will be conducted immediately. An example of a typical inspection form to be used is found in Appendix 13-6.

Should it be necessary to develop alternate water supplies due to unexpected diminution or interruption of flows as a direct result of mining activities, the applicant will contact the Utah Division of Wildlife Resources and develop plans to replace water supplies in quality and quantity on a case-by-case basis. The methodology under consideration and currently in use in other areas are: guzzlers, catch basions, wells and diverting underground mine flow to impacted areas.

14.5.2.5 **Surface Water Monitoring Plan.** A 12-inch parshall flume has been installed at the mouth of Blind Creek (Appendix 14-14, Figure 14-13) to monitor water-levels. This flume is equipped with a Stevens Type-F water-level recorder to allow collection of continuous stream discharge data. Charts will be changed and the flume inspected monthly. Calculations of return-period/peak-flow estimates appear in Appendix 14-14.

Stream flow observations made during drilling operations as well as seep and spring surveys suggest that large portions of the south fork of Horse Creek, Blind Creek, and both the north and south forks of Crandall Creek have only ephemeral and intermittent flows within State Leases ML-21569 and ML-21569. Figure 14-7 and Plate 3-3A show the points of transition between pierrenial and intermittent flow.

Stream channel monitoring stations have been established along both the north and south forks of Crandall Creek, Blind Creek, and the south branch of Horse Creek to determine what stream reaches exhibit perennial flow (Plate 14-5). Stream flow and water temperature will be measured twice monthly from May through July, and monthly during the remainder of 1991 when the area is accessible. Stream monitoring results are found in Table 14-4. Stream monitoring will cease at the end of 1991, and a determination of what stream reaches exhibit perennial flow will be made.

STREAM FLOW AND TEMPERATURE MEASUREMENTS 1991

	APR 15		MAY 28		JUN 12–13		JUL 1–3		JUL 14–16	
STATION	FLOW (gpm)	TEMP (C)	FLOW (gpm)	TEMP (C)	FLOW (gpm)	TEMP (C)	FLOW (gpm)	TEMP (C)	FLOW (gpm)	TEMP (C)
CRANDALL CREEK										
CN–1	188	2	754	6	1997	6	4.7	14	592	11
CN–2	(s)	(s)	673	6	2370	4	4.7	15	250	11
CN–3	(s)	(s)	(s)	(s)	2985	4	–	–	–	–
CN–4	(s)	(s)	(s)	(s)	1683	4	–	–	167	11
CN–5	(s)	(s)	(s)	(s)	422	4	1.5	14	19	9
CN–6	(s)	(s)	(s)	(s)	148	4	1.5	14	8.5	10
CN–7	(s)	(s)	(s)	(s)	447	4	2	16	8	9
CS–1	241	2	467	5	3357	4	3590	10	1037	7
CS–2	(s)	(s)	337	5	2100	4	1234	12	215	6
CS–3	(s)	(s)	930	5	1961	4	185	7	262	5
CS–4	(s)	(s)	DRY	–	1010	3	202	10	DRY	–
CS–5	(s)	(s)	(s)	(s)	1041	3	195	10	34	8
CS–6	(s)	(s)	(s)	(s)	505	2	5	20	DRY	–
CS–7	(s)	(s)	(s)	(s)	107	1	1	13	DRY	–
CF–1	300	4	1400	6	3200	6	1200	12	1647	12
CF–2	300	4	1400	6	3200	6	1200	12	1378	12
BLIND CYN. CREEK										
B–1	(s)	(s)	673	7	1260	7	1005	16	399	18
B–2	(s)	(s)	673	7	1795	7	–	–	–	–
B–3	(s)	(s)	609	6	1000	7	447	12	281	18
B–4	(s)	(s)	448	6	1120	7	207	15	247	16
B–5	(s)	(s)	(s)	(s)	1120	6	419	16	228	19
B–6	(s)	(s)	(s)	(s)	673	4	495	15	–	–
B–7	(s)	(s)	(s)	(s)	337	4	600	15	117	16
B–8	(s)	(s)	(s)	(s)	107	4	280	13	1	320
BF	(s)	(s)	670	7	1000	7	218	18	220	16
HORSE CREEK										
H–1	(s)	(s)	2513	7	705	6	265	19	201	14
H–2	(s)	(s)	1997	7	2000	6	396	18	311	17
H–3	235	1	1387	7	2890	7	300	17	250	13
HN–1	(s)	(s)	590	7	673	4	–	–	3	10
HS–1	(s)	(s)	758	7	1293	3	–	–	20	14
HS–2	(s)	(s)	785	7	1515	3	–	–	31	14
HS–3	(s)	(s)	978	7	1680	4	–	–	100	14
HS–4	(s)	(s)	780	7	2423	6	496	18	167	14
HS–5	(s)	(s)	747	7	2356	6	319	17	131	14
HS–0	(s)	(s)	(s)	(s)	1185	2	97	14	50	14
HS–20	(s)	(s)	(s)	(s)	2015	2	186	16	150	13
HS–30	(s)	(s)	(s)	(s)	1777	1	80	13	71	13
HS–40	(s)	(s)	(s)	(s)	1777	1	65	12	10	13
HS–50	(s)	(s)	(s)	(s)	(s)	(s)	56	12	6	13

Revised 4/8/92

STREAM FLOW AND TEMPERATURE MEASUREMENTS 1991

STATION	AUG 9 FLOW (gpm)	AUG 9 TEMP (C)	AUG 20-21 FLOW (gpm)	AUG 20-21 TEMP (C)	SEP 5-6 FLOW (gpm)	SEP 5-6 TEMP (C)	SEP 25-26 FLOW (gpm)	SEP 25-26 TEMP (C)	OCT 10 FLOW (gpm)	OCT 10 TEMP (C)
CRANDALL CREEK										
CN-1	200	11	103	12	337	10	19	8	25	7
CN-2	112	10	84	12	154	9	25	7	11	6
CN-3	45	12	16	15	309	9	19	5	10	4
CN-4	58	12	55	13	238	9	15	6	5.6	5
CN-5	0.2	12	3	9	10	9	DRY	–	DRY	–
CN-6	1.6	9	DRY	–	66	8	DRY	–	DRY	–
CN-7	0.2	12	DRY	–	25	9	DRY	–	DRY	–
CS-1	337	8	300	8	583	6	210	5	105	7
CS-2	135	8	140	7	95	6	13	7	1.6	8
CS-3	140	6	100	7	75	5	19	6	37	5
CS-4	DRY	–	DRY	–	DRY	–	DRY	–	DRY	–
CS-5	14	10	6	9	17	7	2.7	7	30	5
CS-6	DRY	–	DRY	–	DRY	–	DRY	–	DRY	–
CS-7	DRY	–	DRY	–	DRY	–	DRY	–	DRY	–
CF-1	956	13	620	12	1054	7	406	7	619	8
CF-2	1328	13	620	12	1054	7	406	6	619	8
BLIND CYN. CREEK										
B-1	100	–	56	13	65	11	44	8	30	4
B-2	–	–	56	12	45	11	25	9	31	8
B-3	42	–	18	12	14	11	3.3	7	17	4
B-4	4.4	–	28	11	1.7	11	2	7	6	6
B-5	10.4	–	5	14	0.25	11	2.3	12	–	–
B-6	–	–	8	12	0.25	13	–	–	0.3	18
B-7	–	–	2	12	2	13	0.8	8	0.5	12
B-8	–	–	4	18	5.6	16	0.7	16	0.6	12
BF	229	–	146	14	73	11	146	8	109	5
HORSE CREEK										
H-1	50	17	28	14	14	14	28	7	50	7
H-2	21	17	–	–	12	14	28	8	22	7
H-3	42	18	42	15	12	14	42	10	35	7
HN-1	DRY	–	DRY	–	DRY	–	DRY	–	DRY	–
HS-1	3.5	18	5	13	6	14	6	6	5.6	6
HS-2	13	17	6	13	12	14	9	6	19	4
HS-3	18.7	16	17	13	8	14	13	6	9	5
HS-4	21	17	25	15	8	15	23	6	–	–
HS-5	21	17	16	14	6	14	33	6	72	7
HS-0	1.5	19	5	16	1.5	15	2.3	6	1.5	5
HS-20	0.5	21	0.2	16	0.7	18	2	8	1	6
HS-30	1.0	18	0.5	15	0.5	16	0.2	7	1.5	5
HS-40	0.2	18	DRY	–	DRY	–	0.15	8	DRY	–
HS-50	DRY	–	DRY	–	DRY	–	DRY	–	DRY	–

STREAM FLOW AND TEMPERATURE MEASUREMENTS 1991

STATION	NOV 6-13 FLOW (gpm)	NOV 6-13 TEMP (C)
CRANDALL CREEK		
CN-1	112	5
CN-2	112	1
CN-3	75	2
CN-4	19	1
CN-5	12	2
CN-6	0.5	1
CN-7	DRY	–
CS-1	337	5
CS-2	150	5
CS-3	93	4
CS-4	DRY	–
CS-5	2	1
CS-6	DRY	–
CS-7	DRY	–
CF-1	FRZN	–
CF-2	FRZN	–
BLIND CYN. CREEK		
B-1	168	4
B-2	125	4
B-3	40	4
B-4	18.7	3
B-5	62	3
B-6	–	–
B-7	15.6	2
B-8	15.6	2
BF	FRZN	–
HORSE CREEK		
H-1	701	2
H-2	96	2
H-3	344	1
HN-1	DRY	–
HS-1	37	4
HS-2	93	4
HS-3	84	4
HS-4	84	4
HS-5	122	2
HS-0	112	4
HS-20	9.3	5
HS-30	DRY	–
HS-40	DRY	–
HS-50	DRY	–

(s) Inaccessible due to snow lining stream and/or covering stream.
(–) No data.
(FRZN) Flume frozen.

* Heavy rains fell during Sept 5–6 and July 14–16 surveys. Snow covering and lining the stream was melting during Nov. 6–13 survey

Samples to be analyzed for water quality will be collected quarterly from the flume site. Samples will be analyzed according to the list contained in Table 7-8. In the years 1990, 1995, 2000, and at 5-year intervals thereafter until the bond is released, samples collected during the low-flow period of the year (normally 4th quarter) will be analyzed according to Table 7-9. Samples will be analyzed for total and dissolved constituents according to the above referenced lists. Further details of the surface water monitoring plan are discussed in Section 7.2.6.

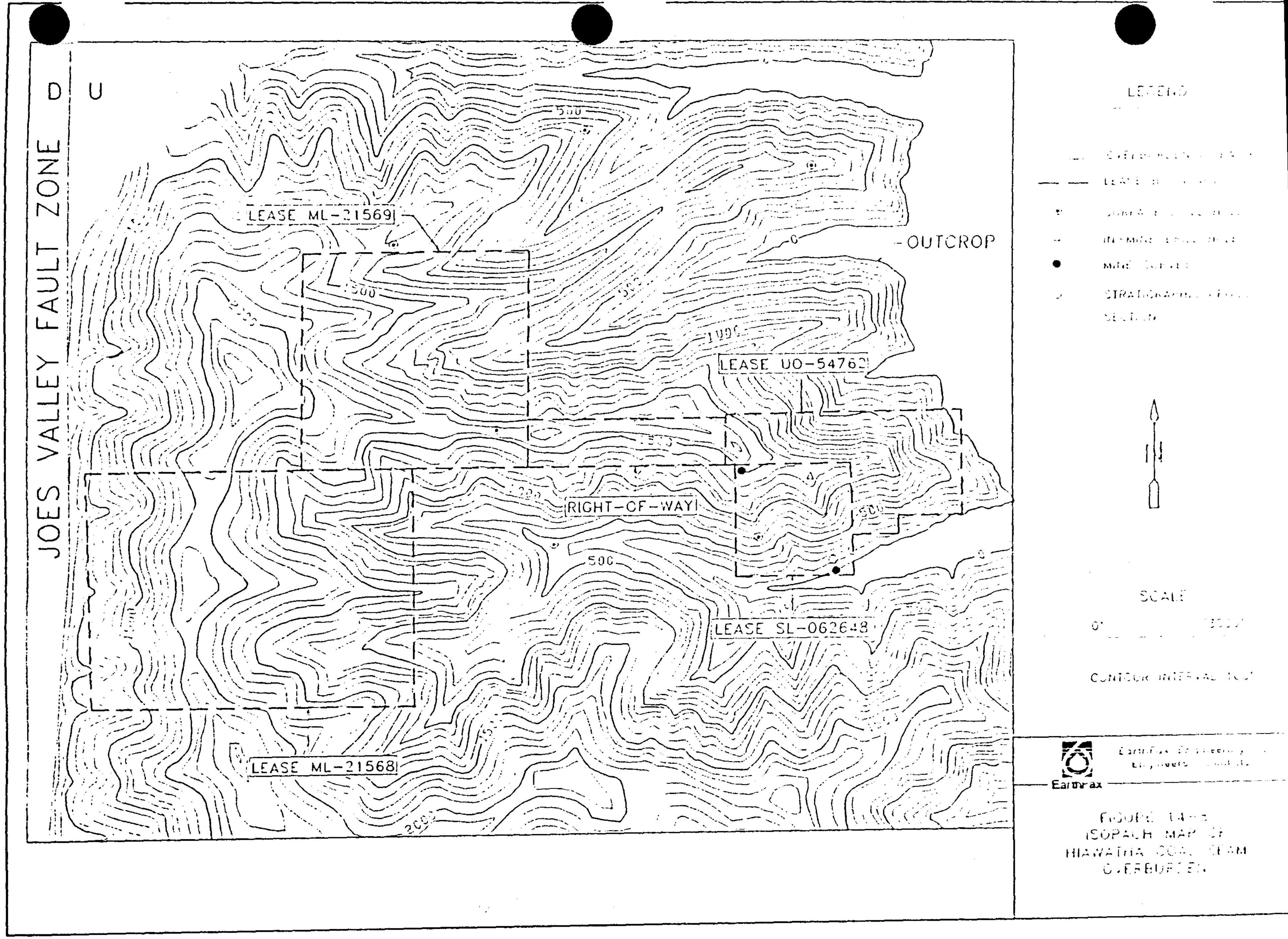
14.6 Geotechnical

14.6.1 Underground Mine Design. An underground mine design has been developed and appears in Plate 14-1. Mined areas within both leases are bordered by barrier pillars a minimum of 100 feet wide. Typical entry-ways are 20 feet wide. Typical pillars are 55 feet wide and 100 feet long, with 75 by 120 foot centers. Five entries comprising "west mains" have been designed as a westward extension of the right-of-way into lease ML-21569. Four entries comprise a north-south submain running along the eastern border of lease ML-21569. Five entries comprise an east-west submain along the northern edge of lease ML-21569. Mains and submains will be first mined only. Eight panels have been designed in lease ML-21569. A barrier pillar 100 feet wide runs along the western edge of the lease. Pillar height in lease ML-21569 varies from five to ten feet.

Lease ML-21568 is to be accessed via five entries which extend southward from West Mains along the eastern edge of the lease. Five entries, running east-west along the northern and southern lease boundaries extend to within 100 feet of the western edge of lease ML-21568, and access 12 panels. Mains and submains will be first mined only. Pillar height is eight feet. A barrier pillar 100 feet wide exists along the western lease boundary.

14.6.1.1 Coal Pillar Design.

An isopach map of the Hiawatha Coal Seam overburden appears in Figure 14-8. Overburden thickness above the area to be mined in Lease ML-21568 ranges from 750 to 2200 feet. The area to be mined in Lease ML-21569 has overburden thicknesses


JOES VALLEY FAULT ZONE
D
U
LEASE ML-21569
LEASE ML-21568
LEASE UO-54762
LEASE SL-062648
RIGHT-OF-WAY
OUTCROP
500
1000
1500
2000
0
SCALE
Earthfax
HIAWATHA COAL SEAM
OVERBURDEN

of 600 to 2100 feet. Coal pillar height is 8 feet in Lease ML-21568, and ranges from 5 to 10 feet in Lease ML-21569. An average uniaxial compressive strength of 1821 psi (geomechanical tests, Appendix 14-15) were used in the pillar safety factor calculations.

Methods used to evaluate safety factors of the pillar design are discussed in Sections 12.3.1 and 12.3.2, as well as in Appendix 12-1. A minimum acceptable safety factor for main entries and rooms are 1.5 and 1.3, respectively (Appendix 12-1). Calculations of pillar safety factors are found in Appendix 14-16. In Lease ML-21568 pillar safety factors for rooms and main entries range from 1.37 to 1.96 and 1.39 to 2.45, respectively. Pillar safety factors for rooms and main entryways in Lease ML-21569 range from 1.47 to 2.45 and 1.78 to 4.37, respectively. As the ratio of pillar length to height approaches 12, pillars are regarded as being able to bear any load (Section 12.3.2). The pillar length to height ratio in Lease ML-21568 is 17.5, and in Lease ML-21569 ranges from 17.5 to 23.3, all well above the value of 12; thus the pillars should be able to bear any load.

14.6.1.2 Roof Span Design. Accepted practice in the Wasatch Plateau is to use 20-foot entry and crosscut widths. Previous experience in the Crandall Canyon and nearby mines have supported this roof span width. Roof span in Leases ML-21568 and ML-21569 is 20 feet in entries and crosscuts. Roof support bolting will consist of a minimum 4 foot resin pins with 5 foot centers.

14.6.2 Subsidence Effects of Mining.

14.6.2.1 Projected Subsidence Effects.

In order to delineate the maximum limit of possible subsidence in the vicinity of Leases ML-21568 and ML-21569, a positive limit (draw) angle of 21° from vertical (69° from horizontal) from the lease boundaries was used. A correction for topographic variability was made in order to accurately determine the maximum surface limit of subsidence. The maximum surface limit of possible subsidence is shown in Figure 14-9. A discussion of the methodology used in determining the maximum limit of subsidence is given in Appendix 14-17. And in

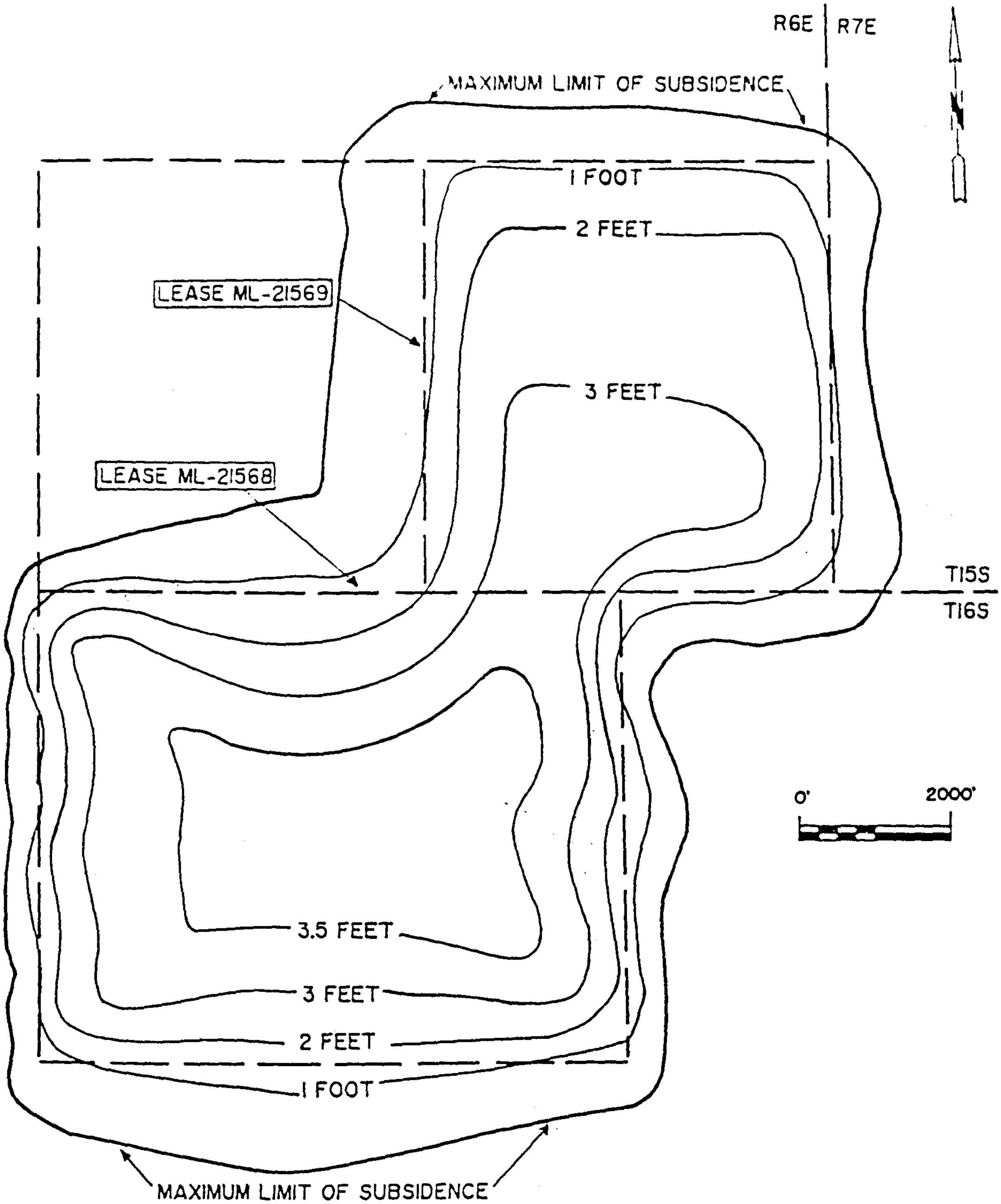


FIGURE 14-9. MAXIMUM SURFACE LIMIT AND MAGNITUDE OF POSSIBLE SUBSIDENCE IN STATE LEASES ML-21568 AND ML-21569 AND SURROUNDING AREA.

EarthFax

the TerraTek report found in appendix 14-9. Draw angles of 15° or less have been observed in moderately strong overburdens in the Book Cliffs and Summerset mining areas of Utah and Colorado, respectively (section 7.1.4).

Maximum subsidence magnitudes that may occur appear in Figure 14-9. The method used in calculating subsidence magnitude is discussed in sections 12.4.1 and 12.4.2, pertinent graphs appear in Appendices 12-3 and 12-4. The maximum amount of possible subsidence is only 3.5 feet, and occurs in the central portions of Lease ML-21568. This 3.5 feet subsidence is worst case and will probably be in the order of 3 to 4 inches according to TerraTek. Subsidence values were calculated by reducing coal thicknesses shown in Plate 3-3 by 50% which represents the unrecoverable coal in the pillared areas. These values were multiplied by 70% to obtain the maximum amount, i.e. worse-case scenario, of subsidence possible (Appendix 12-3). The subsidence values were further reduced in areas bordering the barrier pillar along the perimeter of the leases according to Appendix 12-4. A one foot contour interval was used to map the majority of this subsidence data. A 3.5 foot contour was added to delineate that area where the maximum possible amount of subsidence may occur.

Figures 14-09 and 14-10 shows the extend of worst case maximum subsidence.

Those seeps and springs that lie within the maximum limit of surface subsidence are delineated on Figure 14-10. Seeps and springs within the subsidence limit emit water from the North Horn and Price River Formations 1000 to 2100 feet (100 to 210 times the coal bed thickness) above the interval to be mined. If repeated subsidence via roof failure occurs, elastic deflation is believed to occur at a distance of nine coal seam thicknesses (90 feet) above the coal (see Section 12.4.2). If any tension cracks do develop, they should be sealed by clay migration occurring during elastic deformation. As a result, these seeps and springs should not be affected by subsidence, however monitoring will be conducted as described in section 14.5.1.6.

14.6.2.2 Subsidence Control and Mitigation Methods.

Examinations of federal, state, and county records, as well as the surface revealed there are no man-made structures, utilities right-of-ways, public or

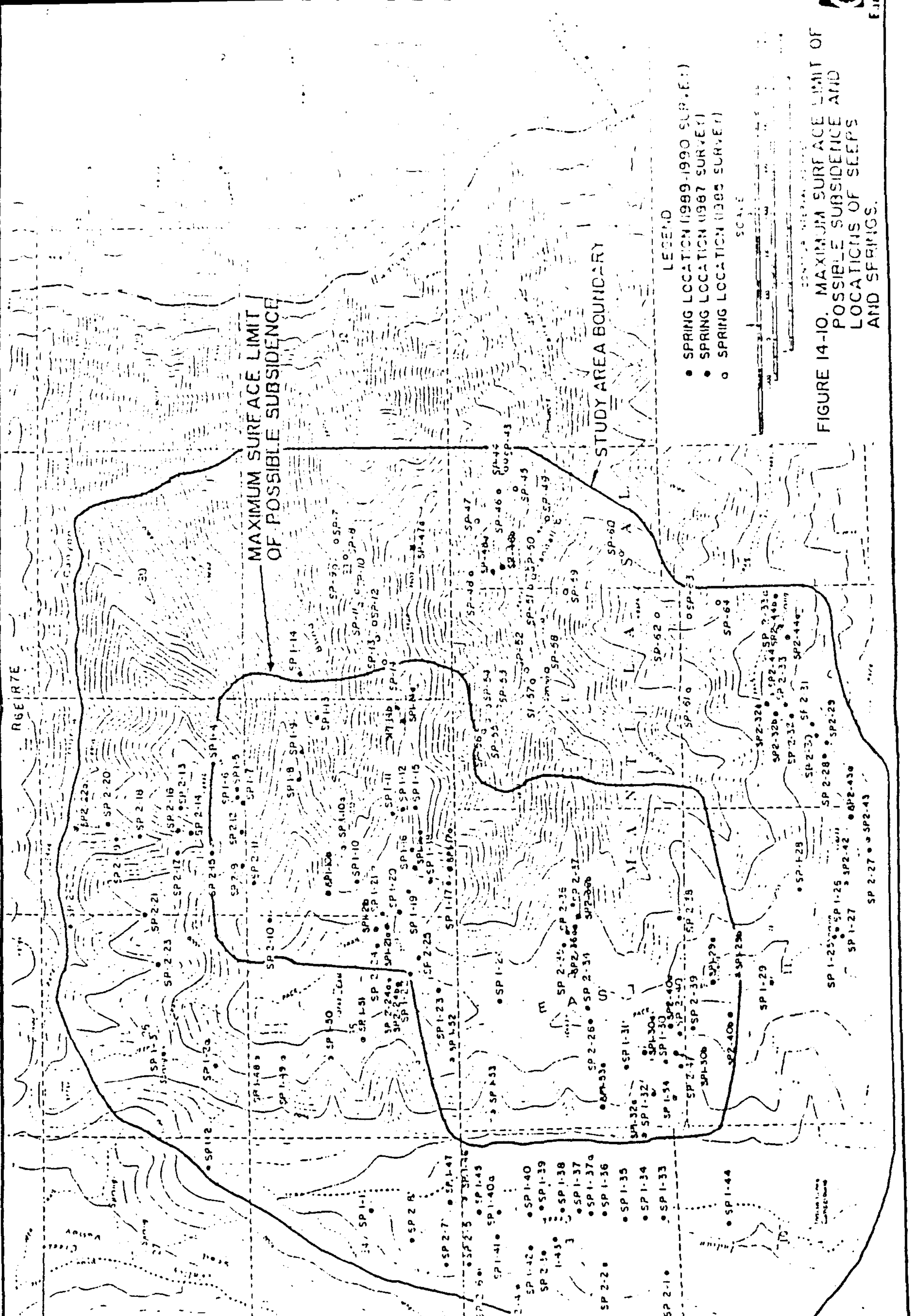


FIGURE 14-10. MAXIMUM SURFACE LIMIT OF POSSIBLE SUBSIDENCE AND LOCATIONS OF SEEPS AND SPRINGS.

private resources necessitating protection from subsidence. Material damage or diminution of value or foreseeable use of lands should not occur.

Genwal recognizes that the Division of Wildlife Resources, the Division of Oil, Gas and Mining, and the United States Forest Service consider all seeps and springs to be important to wildlife. No subsidence mining will take place within the stream channel buffer zones (Plate 3-3) until Genwal has delineated those reaches which exhibit perennial flow, and shown that mining activity will not adversely effect these stream reaches.

Should any seeps and springs become adversely affected, flow decrease by 50% or more due to mining, Genwal will notify the appropriate agencies and begin developing an acceptable mitigation plan.

In the event subsidence negatively impacts grazing, the operator will compensate the owner or appropriate the party by paying the fair market value for the loss experienced. Compensation will be made after the grazing loss is proven to have resulted from surface subsidence.

14.6.2.3 **Subsidence Monitoring Plan**. An aerial (photogrammetric) subsidence monitoring plan has been designed, and is currently being conducted. This method of monitoring subsidence has been implemented in neighboring mines, and meets UDOGM approval. Baseline flight lines were flown over Sections 31 and 32 of T15S-R7E, Sections 5 and 6 of T16S-R7E, Sections 1 and 2 of T16S-R6E, and Sections 35 and 36 of T15S-R6E in October 1989. Pin locations have been surveyed and a pin map generated. Aerial surveys will be conducted each year Leases ML-21568 and ML-21569 are in operation.

14.7 REFERENCES

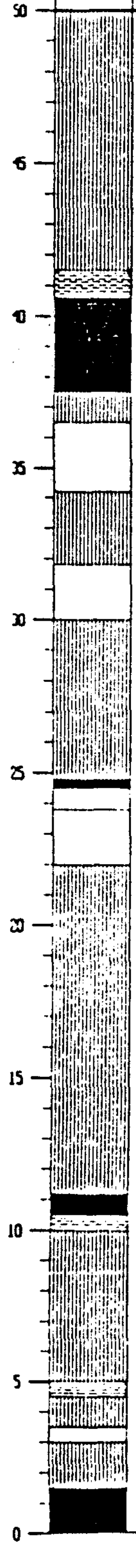
Davis, F.D., and Doelling, H.H., 1977, Coal Drilling at Trail Mountain, North Horn Mountain, and Johns Peak areas, Wasatch Plateau, Utah, Utah Geological and Mineral Survey Bulletin 112, 90 p.

Lines, G.C., 1985, The Ground-Water System and Possible Effects of Underground Coal Mining in the Trail Mountain Area, Central Utah, U.S. Geological Survey Water-Supply Paper 2269, 32 p.

Mcdonald, M.G., and Harbaugh, A.W., 1984, A Modular Three-Dimensional Finite-Difference ground-Water Flow Model, U.S. Geological Survey Open-File Report 83-875, 528 p.

Waddell, K.M., Contratto, P.K., Sumsion, C.T., and Butler, J.R., 1981, Hydrologic Reconnaissance of the Wasatch Plateau-Book Cliffs Coal-Fields Area, Utah, U.S. Geological Survey Water-Supply Paper 2068, 45 p.

Project Name CRANDALL CANYON MINE	Boring/Well Number IMDH-1 MAIN WEST, CROSSCUT #91
Owner/Client GENWALL COAL COMPANY	Boring/Well Location 413,415 7'N 2,084,183 0'E
Project Number UC-27	Reference Elevation 8158 8' AMSL (Drilled up)
Sample Method CORE	Reference Point MINE CEILING
Date Drilled 13 JAN 1992	Drilling Contractor BOYLES
Logged By BKB	Drilling Method ROTARY Rig Type: DIAMEC 260
First occurrence of G W 30-36 5' Static W L --	Boring Depth (ft) 151' UP Well Depth (ft) --
Dates Measured 14 JAN 1992 --	Boring Diameter (in) 3 992"



FORMATION	AGE	LITHOLOGIC DESCRIPTION AND OBSERVATIONS	
		(LOG CONTINUED ON FOLLLOWING PAGE)	
		41 5 - 54 5'	SILTSTONE Light and dark grey, laminae <0 1 - 0 1", carbonaceous fragments, very fine-grained sandstone lenses present, low porosity, moderate HCl reaction, filled gouge fractures
		40 6 - 41 5'	SHALE Light grey, carbonaceous-rich
Cott Coal		37 - 40 6'	COAL Black vitreous luster, blocky
		36 5 - 37 5'	SILTSTONE Dark to light grey, shaley, no porosity, no HCl reaction
		34 2 - 36 5'	SANDSTONE Light grey, silty, low porosity, strong HCl reaction, bioturbated Perched aquifer
		31 8 - 34 2'	SILTSTONE Dark grey, clay-rich
		30 - 31 8'	SANDSTONE Light grey, very fine-grained, low porosity, moderate HCl, reaction, load structures Clay minerals and carbonaceous material along bedding planes Perched aquifer
		24 8 - 30'	SILTSTONE Light to dark grey, carbonaceous-rich, clay minerals present, low porosity, moderate HCl reaction
BLACKHAWK FORMATION	UK		
		24 5 - 24 8'	COAL Black vitreous
		23 8 - 24 5'	SANDSTONE Very fine-grained, carbonaceous material, low porosity low HCl reaction
		22 - 23 8'	SILTY SANDSTONE Fine-grained low porosity, moderate HCl reaction Clay along bedding planes
		11 2 - 22'	SANDY SILTSTONE Dark to light grey, sandstone is very fine-grained, laminae <0 1 to 0 1" thick, no porosity, no HCl reaction
		10 5 - 11 2'	COAL Black, vitreous, resinous
		10 - 10 5'	SILTY SHALE Dark grey, carbonaceous-rich, coal lenses up to 1/8" thick
		5 - 10'	SHALEY SILTSTONE Sand lenses present in minor amounts, carbonaceous fragments, low porosity, mild HCl reaction
		4 6 - 5'	SILTY SHALE Grey to light grey
		4 5 - 4 6'	SHALE Black, carbonaceous-rich, laminae <0 1"
		3 5 - 4 5'	SHALEY SILTSTONE Dark grey, low porosity, no HCl rxn
		3 0 - 3 5'	SANDSTONE Light grey, fine to very fine-grained, low porosity, no HCl reaction
		1 5 - 3'	SILTSTONE Light grey, carbonaceous-rich, low porosity, no HCl reaction
Hiawatha Coal		0 - 1 5'	COAL Black, vitreous, resinous, blocky
		ROOF OF MINE	

WELL COMPLETION DETAILS

3.992" Drill hole

Cement

5" Surface Casing 0-4'

Project Name: CRANDALL CANYON MINE	Boring/Well Number: IMDH-1 MAIN WEST, CROSSCUT *91
Owner/Client: GENWALL COAL COMPANY	Boring/Well Location: 413,415 7'N 2,084,183 0'E
Project Number: UC-27	Reference Elevation: 8158 8' AMSL (Drilled up)
Sample Method: CORE	Reference Point: MINE CEILING
Date Drilled: 13 JAN 1992	Drilling Contractor: BOYLES
Logged By: BKB	Drilling Method: ROTARY Rig Type: DIAMEC 260
First occurrence of G.W.: 30-36 5' Static W.L.: --	Boring Depth (ft): 151' UP Well Depth (ft): --
Dates Measured: 14 JAN 1992 --	Boring Diameter (in): 3 992"

FORMATION	AGE	DEPTH (FT)	LITHOLOGIC DESCRIPTION AND OBSERVATIONS	WELL COMPLETION DETAILS
		100	(CONTINUED ON FOLLOWING PAGE)	
			98 7 - 99' COAL Black, boney	
			98 - 98 7' SILTSTONE Shaley, carbonaceous-rich	
			96 8 - 98' COAL Black, vitreous luster, resinous	
		95	91 8 - 96 8' SILTSTONE Interbedded black shale (up to 0 5" thick) and light tan sandy siltstone, low porosity, strong HCl reaction	
			Vertical Fracture from 92 - 93 5'	
Blind Canyon Coal		90	88 8 - 91 8' COAL Black, vitreous luster, resinous	
			86.7 - 88 8' SILTSTONE Light grey, laminae <0 1 - 0 1"	
		85	84 - 86 7' COAL Black, vitreous luster, resinous	
			74.9 - 84' SANDSTONE Light grey, very fine-grained, wavy bedding, low porosity, moderate HCl reaction	3.992" Drill hole
		80		
BLACKHAWK FORMATION	UK	75	74 5 - 74 9' COAL Black	Cement
			73.5 - 74 5' SANDSTONE Light grey, wavy lamination, low porosity, moderate HCl reaction	
			72 - 73 5' SILTSTONE Carbonaceous-rich, silty coal seams up to 2" thick	
			69.5 - 72' SANDSTONE Light grey, very fine-grained, wavy bedding, moderate porosity, strong HCl reaction	
		70	67 5 - 69 5' SANDSTONE Silty, very fine-grained, clay minerals along bedding planes	
			65 - 67 5' SANDSTONE Light grey, silty, very fine-grained, clay minerals along bedding planes	
		65	61.5 - 65' SANDY SILTSTONE Light grey, clay and carbonaceous material abundant along bedding planes, bioturbated	
			60 8 - 61 5' SHALEY SILTSTONE Medium grey, abundant carbonaceous material and coal seams up to 1/4" thick, no porosity, no HCl reaction 1/4" coal seam at 61 3'	
		60	55 9 - 60 8' SILTSTONE Sandy, light grey, carbonaceous and clay minerals along bedding planes	
			54 9 - 55 9' SANDSTONE Light grey, very fine-grained, carbonaceous material and clay minerals along bedding planes, low porosity, moderate HCl reaction	
		55	54 5 - 54 9' COAL Black, vitreous	
		50		

Project Name: CRANDALL CANYON MINE	Boring/Well Number: IMDH-1 MAIN WEST, CROSSCUT #91
Owner/Client: GENWALL COAL COMPANY	Boring/Well Location: 413,415 7'N 2,084,183 0'E
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Logged By: BKB	Drilling Method: ROTARY Rig Type: DIAMEC 260
First occurrence of G.W.: 30-36.5' Static W.L.: --	Boring Depth (ft): 151' UP Well Depth (ft): --
Dates Measured 14 JAN 1992 --	Boring Diameter (in): 3.992"

FORMATION	AGE	DEPTH (FT)	GRAPHICAL LOG	LITHOLOGIC DESCRIPTION AND OBSERVATIONS	WELL COMPLETION DETAILS
		150		147.3 - 150.5' SILTSTONE Grey, low porosity, moderate HCl reaction Interbedded with dark grey shale	
Upper Bear Coal				146.75 - 147.3' COAL Black, boney, silty, no porosity, no HCl reaction	
				146 - 146.75' SILTY SHALE Carbonaceous-rich, very low porosity, moderate HCl reaction	
		145		144 - 146' SILTSTONE: Light grey, low porosity, moderate HCL reaction Interbedded with dark grey shale	
				142.8 - 144' SILTSTONE Carbonaceous-rich, very low porosity, very weak HCl reaction 1" coal seam at 142.8'	
				141 - 142.8' SILTY SANDSTONE Very fine-grained, low porosity, mild HCl reaction	
		140		138 - 141' SILTSTONE Dark to light grey, low porosity, moderate HCl reaction Interbeds of dark grey to black shale and very fine-grained sandstone	
				123.5 - 138' SANDSTONE Light grey, very fine-grained, massive to wavy-bedded, low porosity, moderate HCl reaction	3.992" Drill hole
		135			
		130			Cement
BLACKHAWK FORMATION	UK			Natural vertical fracture 124 - 127'	
		125			
				112.9 - 123.5' SILTSTONE Light and dark grey, laminae <0.1 - 0.2" thick, low porosity, moderate HCl reaction Interbedded with dark grey shale Siltstone beds up to 2" thick, shale beds up to 1.5" thick	
		120			
		115			
				112.1 - 112.9' COAL Black, vitreous luster	
				110 - 112.1' SILTSTONE Siltstone and very fine-grained sandstone interbedded with carbonaceous-rich shale	
		110		109.5-110.1' COAL Black, boney, vitreous luster	
				109 - 109.5' COAL Black, boney, siltstone intraclaste	
Bear Coals				108 - 109' COAL Black, vitreous luster, minor amounts of clay minerals, resinous	
				106.7 - 108' SHALE Carbonaceous-rich, coal intraclasts	
				105.9 - 106.7' COAL Black, vitreous luster	
		105		103.5 - 105.9' SILTSTONE Shaley, light grey, very low porosity, moderate HCl reaction	
				99 - 103.5' SILTSTONE Very fine-grained, sandy laminae have carbonaceous and clay minerals, laminae <0.1 - 0.1" thick	
				Fracture from 100 - 101.2', dipping 80 - 90 degrees	
		100			

Project Name CRANDALL CANYON MINE	Boring/Well Number IMDH-1 MAIN WEST, CROSSCUT *91
Owner/Client GENWALL COAL COMPANY	Boring/Well Location: 413,415.7'N 2,084,183.0'E
Project Number UC-27	Reference Elevation 8158.8' AMSL (Drilled up)
Sample Method CORE	Reference Point MINE CEILING
Date Drilled 13 JAN 1992	Drilling Contractor BOYLES
Logged By BKB	Drilling Method ROTARY Rig Type: DIAMEC 260
First occurrence of G.W. 30-36.5' Static W.L. --	Boring Depth (ft) 151' UP Well Depth (ft): --
Dates Measured 14 JAN 1992 --	Boring Diameter (in) 3.992"

FORMATION	AGE	DEPTH (FT)	GRAPHICAL LOG	LITHOLOGIC DESCRIPTION AND OBSERVATIONS	WELL COMPLETION DETAILS
		200			
		195			
		190			
		185			
		180			
		175			
		170			
		165			
		160			
		155			
BLACKHAWK FORMATION	UK	150		150.5 - 151' SILTY SANDSTONE Very fine-grained, low porosity, moderate HCl reaction	Cement